NAVAL POSTGRADUATE SCHOOL
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THESIS

THE INTRODUCTION OF UNCERTAINTY TECHNIQUES TO THE PRODUCTIVITY INVESTMENT FUND

by

Edward A. Lenio

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Thesis Advisor: D. C. Boger

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Each year the Defense Productivity Program Office (DPPO) disburses funds for Productivity Investment Projects (PIFs). The purpose of these projects is to increase productivity within the Department of Defense (DoD). To enhance these efforts, DPPO requested a study to be conducted to determine if methods of risk or uncertainty will affect the results obtained by the current procedure. This study applies

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various principles of uncertainty to this procedure and examines their impact on the project rankings. A background of DPPO and PIFs is presented together with discussion of risk and uncertainty techniques, as well as the economic indicators used in ranking projects. A model is then explained which will introduce uncertainty into the present procedure. Results of the initial comparison and sensitivity analysis is revealed. Conclusions are drawn based on these results and recommendations concerning alternate procedures and possible further research are presented.

The Introduction of Uncertainty Techniques to the Productivity Investment Fund

by

Edward A. Lenio
Lieutenant Commander, United States Navy
B.A., The Citadel, 1974

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ABSTRACT

Each year the Defense Productivity Program Office (DPPO) disburses funds for Productivity Investment Projects (PIFs). The purpose of these projects is to increase productivity within the Department of Defense (DoD). To enhance these efforts, DPPO requested a study to be conducted to determine if methods of risk or uncertainty will affect the results obtained by the current procedure. This study applies various principles of uncertainty to this procedure and examines their impact on the project rankings. A background of DPPO and PIFs is presented together with discussion of risk and uncertainty techniques, as well as the economic indicators used in ranking projects. A model is then explained which will introduce uncertainty into the present procedure. Results of the initial comparison and sensitivity analysis is revealed. Conclusions are drawn based on these results and recommendations concerning alternate procedures and possible further research are presented.

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I. INTRODUCTION

A. BACKGROUND

As early as February 1969, the Department of Defense (DoD) began to place emphasis upon increasing efficiency and productivity within its department. This was also complementary to the overall efforts of the federal government. These efforts led to the creation of the Defense Productivity Program (DPP) whose primary objective is "to achieve optimum productivity growth (increase the amount of goods produced or services rendered in relation to the amount of resources expended) throughout DoD" [6: pg. 1]. It should be noted that this does not include contractors. It is intended solely for DoD and the Service Components. Furthermore, this approach called for the development of Productivity Enhancing Capital Investments (PECIs). Responsibility for the administration of the program was assigned to the Assistant Secretary of Defense; Manpower, Reserve Affairs and Logistics (ASD(MRA&L)) who designated his authority to the Defense Productivity Program Office (DPPO). This Office acts as the coordinator for the DPP and serves as liaison between the Office of the Secretary of Defense (OSD) and Service Components in productivity matters.

One of the problems faced by DPPO in the management of PECIs was the process of allocating funds. Due to budget

constraints, not all of the recommended productivity projects could receive funds. To alleviate this dilemma, projects are ranked according to three economic indicators: internal rate of return (IRR); return on investment (ROI); and investment per manpower space saved (INVPERSV). Projects then receive funding according to their rank until the budget for that fiscal year is exhausted.

B. STATEMENT OF THE PROBLEM

DPPO's concern is to ensure that funds are allotted to the most productive projects. Considering that projects forecast uncertain savings and costs into the future, this is an understandable concern. Under the present procedure, DPPO can only validate the use of correct discount rates in making these predictions. However, the realization of these forecasted costs and savings is questionable. The introduction of methods involving risk and uncertainty may aid in the efficient allocation of funds. The question to be addressed in this thesis is whether or not the use of risk and uncertainty techniques will significantly change the current ranking of projects.

C. OBJECTIVES OF THE ANALYSIS

The objectives of this analysis will be to develop a model incorporating uncertainty, rank the projects using the model, and compare these results to the current ranked list. Since the present method ranks projects according to IRR,

ROI, and INVPERSV, the model will apply risk factors to these areas. The model will not introduce any new variables (e.g., net present value, payback period, etc.) which might affect the rankings. Furthermore, only those equations used by DPPO to calculate economic indicators will be presented in the model unless a simpler formula exists that portrays identical behavior. This specifically refers to the method used to compute IRR. The current method uses average yearly savings and the model utilizes constant yearly savings. Although the formulas will result in different IRRs, any change in savings will result in an equi-proportional change in rate of return.

Additionally, sensitivity analysis will be performed on the model. Initial analysis will restrict itself to the single variable case and will be expanded later to consider multivariable deviations. The purpose of this analysis will be to determine the level of change of input variables to effect a change in ranking.

D. CONTENTS

The following chapter introduces the reader to DPPO and the Productivity Investment Fund (PIF). The background of DPPO and its functions, an overview of PECI's, the PIF's past funding levels, and procedures used to obtain these funds will be addressed. Chapter III will familiarize the reader with risk and uncertainty as well as techniques in dealing with each. It will further apply the use of

uncertainty to the PIF. Chapter IV defines the terms and gives a detailed description of the model. It will explain how branch values were obtained and discuss the basic assumptions of the model. In Chapter V, the ranking derived using uncertainty will be compared to the current ranking, sensitivity analysis performed, and the results of the analysis revealed. Chapter VI will summarize this thesis and present conclusions and recommendations derived therefrom.

II. DEFENSE PRODUCTIVITY PROGRAM OFFICE (DPPO)

A. BACKGROUND

As previously stated, emphasis on productivity and efficiency within the Department of Defense (DoD) began in 1969. Initial attempts called for the establishment of the Defense Economic Analysis Council in October 1972. This council served in an advisory capacity to the Assistant Secretary of Defense (Comptroller) and encouraged the application of economic analysis and program evaluation in order to increase the cost effectiveness of budget proposal inputs to the Planning, Programming and Budgeting System (PPBS). In August 1975, DoD Directive 5010.31 established the Defense Productivity Program. The primary objective of the program is "to achieve optimum productivity growth (increase the amount of goods produced or services rendered in relation to the amount of resources expended) throughout DoD" [6: pg. 1]. This directive required Defense organizations to be both effective and efficient in the utilization of all types of fund resources (operating and investment) as well as labor resources. Furthermore, the directive identified productivity measurement, productivity enhancement, and productivity evaluation as key elements to the program. Although all three elements play important roles in the program's success, only Productivity Enhancement (PE) will be discussed in this paper.

In 1979 DoD Directive 5010.31 was reissued, forming the Defense Productivity Program Office (DPPO) which had overall responsibility of the Defense Productivity Program (DDP). DPPO was placed under the cognizance of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) (ASD, MR&L) in 1981.

The DPP to be developed would include a planned approach to PE including, but not limited to, the development of Productivity Enhancing Capital Investment (PECI) programs. PECIs are classified as:

1. Office of the Secretary of Defense (OSD) sponsored projects;
2. Industrial Fund Fast Payback (IFFP) projects; and
3. Other Component Sponsored Investment (CSI) projects.

OSD sponsored projects include the following categories:

a. Productivity Enhancing Incentive Fund (PEIF) projects. These projects are

> ...fast payback PECI projects financed from drawing accounts established within annual appropriations. These projects cannot exceed $100,000 or cost limitations established by OSD (whichever is greater) and must amortize within 2 years of the date they become operational. [7: pg. 4]

b. Productivity Investment Fund (PIF) projects. These are projects that have been

> ...competitively selected by OSD from candidate proposals submitted by DoD Components and financed through traditional budget appropriation processes from funds set aside by OSD for this purpose. PIF projects must be expected to amortize within 4 years of the date they become operational. [7: pg. 4]

Since this thesis will deal only with PIF projects, discussion on PEIF, IFFP and CSI projects will be omitted. However, PIF funding levels and procedures will be of interest later and will be the next topic.

B. PRODUCTIVITY INVESTMENT FUND (PIF) FUNDING LEVELS

To better understand the magnitude of these investments, a look at past and proposed funding levels may prove beneficial. The first PIFs were funded in 1981. Money for the program was $105 million that year and $110 million for 1982. David Whipple and Jack LaPatra [15] completed an evaluation of DPPO's activities revealing,

> The average cost of PIFs has been $2 million, with an average payback of 2.5 years. Having an average lifetime investment of $11.2 million, they are expected to return $6 for $1 invested. Approximately $700 million has been requested under PIF by all services for FY 83-87. [15: pg. V-15]

The average cost of proposed projects for FY84 budgeting is approximately $1.6 million, slightly less than previous years. How a Service Component proceeds to obtain funding for a productivity project is the next topic.

C. PIF FUNDING PROCEDURE

Department of Defense Instruction (DoDI) 5010.36 establishes policy and prescribes procedures for the Productivity Enhancing Capital Investment (PECI) program with which the PIF is affiliated. Excerpts from this directive concerning policy indicate the intent of the program by stating, "PECI funding procedures focus upon financing those projects that

substitute capital for labor" [7: pg. 2]. In yet another section, guidelines for project selection is delineated,

> Top priority will be given to those potential investments that amortize in the shortest period of time and those with the highest potential internal rate of return on investment or the highest net present value. [7: pg. 2]

Furthermore, the instruction dictates a specific format for DoD Components to follow when requesting money for productivity projects. A copy of the format is contained in Reference 7. Some of the required information that will be of particular interest later includes total cost, total savings, internal rate of return (IRR), savings to investment ratio, rate of investment per manpower space and cost-benefit streams. These concepts are explicitly defined and evaluated in Chapter IV below. From this base, net present value (NPV) and payback period (P-P) can be calculated and economic analysis performed. For purposes of uniformity, the term savings to investment ratio is synonymous with return on investment (ROI).

The sequence of events from project initiation to project funding may be outlined as follows:

1. A DoD Component prepares an initial proposal for a project categorized as a PIF using the format af DoDI 5010.36.

2. This proposal is forwarded via the appropriate chain of command for approval.

3. Each service then compiles a list of the "best" projects, normally in rank order, that meets its needs and objectives.

4. These lists are then forwarded to DPPO who conducts an economic screen. The screening process consists of recomputing the information and checking the accuracy of each proposal in terms of calculations and validity of projections.

5. The projects are separated according to function, i.e., Automatic Data Processing (ADP), aircraft maintenance, etc., and forwarded to the appropriate Office of the Secretary of Defense (OSD) Functional Manager for a final screening.

6. Projects are returned to DPPO who computes a final ranking of all approved projects. This ranking is based on three key indicators: IRR, ROI and Investment Per Manpower Space Saved (INVPERSV). Each indicator receives equal weight with ties in rank going to the project with the highest IRR.

7. From the current budget set aside for PIF projects, all out-year funding on prior approved projects is deducted, i.e., a FY81 project requiring funds for two years receives its FY82 money from the FY82 budget. A running cumulative sum of investment costs on currently approved projects is performed and the balance of PIF monies allotted. It should be noted that not all projects approved will be funded.

8. DPPO then issues a Program Budget Decision (PBD) to the services who, in turn, add this money to their respective Service Budget requests.

9. Once Congressional approval is received, as it usually is, the funds are appropriated accordingly. This entire

cycle takes approximately 1 year to complete and any project not funded that year may reapply the following year.

At this point, the reader should have a basic understanding of DPPO, PIF and the procedures used to obtain project funding. What may not be so clear is the role that risk and uncertainty play. The next chapter attempts to introduce these terms and relate them to the PIF.

III. RISK AND UNCERTAINTY

A. INTRODUCTION

The word decision may be defined as a choice among alternatives. In any investment, a decision may be made under conditions of certainty, risk, or uncertainty. Certainty postulates that the decision maker knows in advance all parameter values that will affect the decision. With risk, he is aware of all future states that will affect his decision and can place a probability distribution on the value of the occurrence of each state, i.e., the probability distribution which describes possible outcomes is known. According to Morris [13], uncertainty implies that a decision maker may or may not be aware of all possible states and may or may not be able to place a probability distribution on the occurrence of each.

Figure 1 depicts a decision problem represented by a payoff matrix. Here, the columns, $s_1, s_2, \ldots, s_n$, represent future states of nature and the rows $a_1, a_2 \ldots, a_m$ are the alternatives. The P_{ij}'s, where $i = 1,2,\ldots,m$ and $j = 1,2,\ldots,n$, represent the payoff of alternative i in state j. If a probability distribution can be placed on the states of nature, then Morris [12], Fishburn [8], Luce [10] and Savage [14], give several principles that may be used to aid in decision making. These principles, expectation, most probable

	s_1	s_2	...	s_n
a_1	P_{11}	P_{12}	...	P_{1n}
a_2	P_{21}	P_{22}	...	P_{2n}
⋮	⋮	⋮		⋮
a_m	P_{m1}	P_{m2}	...	P_{mn}

Figure 1. Typical Payoff Matrix

future, expectation-variance, and aspiration level, will be discussed in detail in Chapter IV. If the decision is made under uncertainty, then the Laplace Principle, minimiax or maximin, minimin or maximax, Savage's minimax regret, and the Hurwicz principle are common principles of choice.

Clark, et al [4] explain another technique in dealing with risk and uncertainty known as Utility Theory. This is an attempt to formalize rational decision making. In this approach, preferences among alternatives are specified by the decision maker. The utility value attached to the various alternatives then represent all aspects that are relevant to the decision.

If a decision maker perceives different levels of risk associated with the future states, then the Certainty Equivalent Method may prove useful. This approach permits adjustment for risk by incorporating the decision maker's utility preference for risk. In an economic scenario, it is reasonable to assume that estimates of cash flows are

likely to be more accurate during the early periods of an investment than in the later years. Subsequently, the risk should be adjusted to reflect this. In dealing with similar situations, whether economic or not, the certainty equivalent method may be preferred.

Raiffa [13] explains a popular decision technique known as a decision flow diagram or "tree." Here, a manager has several courses of action he may take. For each course of action, there may be several consequences associated with it. Furthermore, with each consequence there exists a probability of that event occurring. Figure 2 depicts a simple example of a decision tree. In this example, a decision maker has a choice of investing $15,000 on a project.

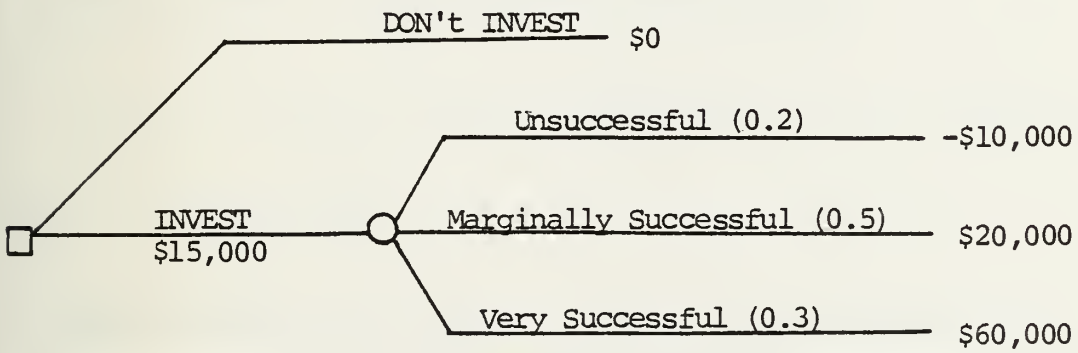

Figure 2. A Simple Decision Tree

If he decides not to invest, he gains or loses nothing. If he invests, then the project will be unsuccessful with probability 0.2, marginally successful with probability of 0.5 or highly successful with probability 0.3. In this

particular case the decision maker faces an 80 percent chance of a successful project. Taking this one step further, the principle of expectation or expected value can be used. Mathematically, expected value, $\bar{R}$ is

$$\bar{R} = \sum_{i=1}^{N} R_i P_i \qquad (1)$$

where:

$\bar{R}$ is expected value,

R_i is the value of the ith outcome,

P_i is the probability the ith outcome occurs,

N is the total number of outcomes.

Applying this to the decision tree yields

$$\bar{R} = (-\$10{,}000 \times 0.2) + (\$20{,}000 \times 0.5) + (\$60{,}000 \times 0.3)$$

$$= \$26{,}000.$$

Depending upon the decision maker's risk posture, i.e., the minimum return he will accept on this investment, he may or may not invest.

It should be noted that the probabilities associated with the occurrence of consequences may not be very easy to obtain. When reviewing the available courses of action, the decision maker always has the option of delaying a decision until further data can be gathered which might provide insight

into the results of the various choices. However, delaying a decision usually has an associated cost. This cost may be in terms of time, money, workforce or numerous other things. According to Mooney [11], significant in this area are the benefits derived from increased information and the increase in certainty as a function of time. Figures 3 and 4 graphically illustrate this problem.

The dilemma of determining how much information is cost effective can often be viewed as a problem itself. How one obtains information can help in reducing costs. If data is readily available, the tools of regression, data analysis, non-parametric statistics and probability theory can be useful in providing a structured solution. On the other hand, if facts must be gathered, then other techniques may be used as well. Moody [11] suggests several non-mathematical means available including consensus thinking, brainstorming, the delphi principle, fish bowling, didactic interaction and collective bargaining. In addition to the above, other methods such as PERT (Program Evaluation and Review Technique) and QUID (Quantified Intrapersonal Decision Making) are becoming readily accessible.

B. APPLICATION OF RISK AND UNCERTAINTY TO THE PIF

During the funding process for Productivity Investment Funds (PIF), each project is checked for accuracy in its projections. Components requesting funds review and analyze past data on costs, workloads, etc., in an attempt to forecast

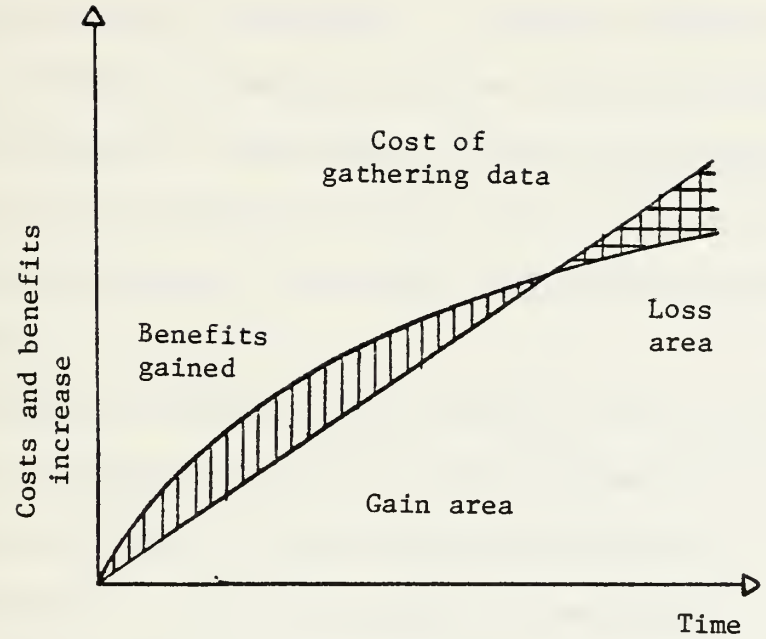

Figure 3 Cost-Benefit Time Curve

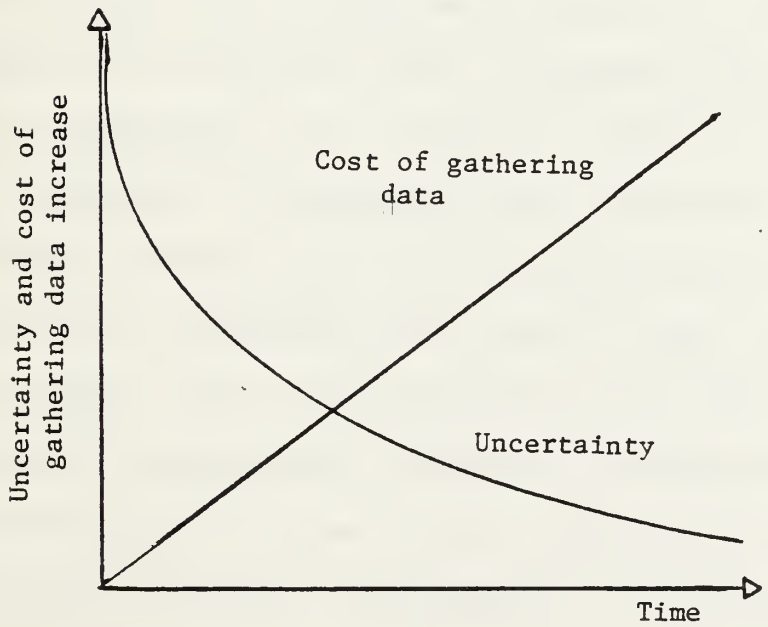

Figure 4 Cost-Uncertainty Time Curves

costs and savings into the future. These savings are the key to calculating such indicators as internal rate of return (IRR), return on investment (ROI), and investment per manpower space saved (INVPERSV). However cautious and meticulous an analyst or manager may be, these savings may or may not be realized. Techniques of risk and uncertainty may aid in taking futuristic inputs into account and better predicting savings. An example might best portray this statement.

Consider a machine that extracts rivets from aircraft wings at a rework facility. The investment cost of the machine is $60,000. Since the cost incurred is in the very near future, it will be assumed to be accurate (providing installation costs, transportation costs, etc., have been incorporated). In the cost-benefit stream, savings are forecast to be $30,000 per year for 10 years. Furthermore, assume the projected savings were based on a constant workload, that of the current level, throughout the economic life of the machine, i.e., 10 years. Clearly such factors as war, depression or recession, the introduction of a low maintenance aircraft, etc., could substantially increase or decrease the workload of the facility and, hence, projected savings. The list of factors that could affect the projections is practically endless. To construct a model incorporating all of these factors would be tedious and costly, with the model becoming unmanageable. If risk and uncertainty

were used on a macro level, most of these problems would be alleviated. (The word macro is used here to distinguish the analysis from a micro aspect.) The micro aspect of analysis would consider each factor, to achieve the final result. In the macro sense, one is concerned only with whether or not realized savings were above, below, or as projected without concern for the factors that would cause it to deviate. The macro model could enhance managability and still yield workable results, especially if not one, but 50 to 100 projects had to be dealt with.

The impact of risk and uncertainty in dealing with PIF projects should be apparent. The methodology and model used toward this end is presented in following chapters. It should be noted that the procedure used is not exclusive to investments alone, nor is it the only method applicable for analysis. Variations on this theme will also be mentioned later.

IV. AN ECONOMIC MODEL

A. DEFINITIONS

The underlying motive of any business is to make a profit. One method of achieving this is through capital investments. It follows that managers expect money invested today to increase in amount as time passes because they expect to earn a profit on that investment. To the manager, therefore, the value of money today is more than its value at some future time. Anthony and Reese [1] make an interesting analogy, "An investment is thus the purchase of a future stream of expected cash inflows" [2: pg. 710]. Cash inflows are simply earnings or savings.

If several investment alternatives exist, then a basic criterion must be established for the purposes of comparison and evaluation. Although five criteria are explained next, only three (IRR, ROI, INVPERSV) are used by DPPO.

The first economic indicator, Net Present Value (NPV), is the difference in the present value of the benefits (savings) and the present value of the costs at a given discount rate (the interest rate used to discount or calculate future costs and benefits so as to arrive at their present values). Mathematically, this may be expressed as:

$$NPV = \sum_{t=1}^{n} \frac{S_t}{(1+k)^t} - A_0 , \qquad (2)$$

where:

A_0 = present value of the cost of the project,

S_t = savings received in period t,

k = appropriate discount rate,

t = time period, and

n = useful life of asset.

If A_0 is incurred over a period of time, then

$$A_0 = \sum_{t=1}^{n} \frac{A_t}{(1+k)^t}, \qquad (3)$$

where A_t is the cost during period t. If the NPV is positive, it means the project is expected to yield a return in excess of the required rate. If it is zero, the yield is expected to equal the required rate.

The discount rate that equates the present value of the future cash flows with the present value costs of an investment is known as the Internal Rate of Return (IRR). This is calculated by determining the discount rate that will make the NPV zero:

$$\sum_{t=1}^{n} \frac{S_t}{(1+r)^t} - A_0 = 0, \qquad (4)$$

where:

r = IRR,

S_t = savings received in period t,

t = time period,

A_0 = investment cost, and

n = useful life of asset.

If cash inflows are uneven, the trial and error method is recommended. Computers ease the tediousness of the computation; however, DoD has derived a more simplistic procedure. Dividing the project cost by the average annual savings will yield a factor. This factor and the number of years in the economic life of the project can be used to enter a table and select the IRR. If the cash inflows are even, Anthony and Reese [1], using the same calculation, offer the IRR based upon the same table inputs.

The Payback Period (P-P) refers to the number of periods required for the (undiscounted) cumulative cash inflows to have the same value as the investment cost.

Another indicator, Return On Investment (ROI), is synonymous with the savings to investment ratio. This method compares yearly income of a project with the investment in the asset [1: pg. 52]. The formula used by DPPO is:

$$ROI = \frac{\sum_{t=1}^{n} S_t}{\sum_{t=1}^{n} C_t} \qquad (5)$$

where:

S_t = savings received in period t

C_t = costs incurred in period t

t = time period

n = useful life of the asset.

Finally, the Investment Per Manpower Space Saved (INVPERSV) is simply an indicator that compares cost to manpower. A manpower space is best defined by example. If two clerks are required to perform a task, and the introduction of a new system requires only one of them, then the other is freed and can be assigned elsewhere. This equates to saving one manpower space.

B. THE MODEL

Although the techniques of both risk and uncertainty have been discussed, the model that will be presented next will deal strictly with uncertainty. This is not to say that the model could not be used with risk. After careful analyses of several audit reports, there was not enough information to derive probability distributions, thus eliminating the introduction of risk. In particular, the audit reports, for the most part, failed to compare actual (or realized) costs or savings to that which was proposed. Without this information, it would be extremely difficult to obtain probability distributions (the use of subjective probabilities could have been used). Further discussion on this point is contained in Chapter VI.

In the process of evaluating and ranking PIF projects, DPPO used three indicators; IRR, ROI and INVPERSV. The

model, therefore, will contain three submodels used to evaluate each indicator respectively. A tree diagram was used in each submodel in order to present the different outcomes in an orderly fashion. Figures (5), (6) and (7) are graphical representations of these models. The underlying assumption used in the development of each diagram is based on the independence of cost, savings, manpower space saved (MPS) and cash flow. The term independence is used to signify that an outcome of one variable is not dependent on any of the others. This assumption allows one to branch out the different future states of nature and then apply uncertainty techniques.

It should be noted that the IRR model utilizes one branch instead of two as represented in the other models. This was done for two reasons. The first is that Sciortino's [1] audit of FASCAPs (Fast-Payback Capital Investments) revealed that 11.7 percent of all funded projects resulted in cost overruns of 10 percent of the total projected cost. This sum did not appear to be significant in comparison to the total cost of all of the funded projects. Secondly, the program used to evaluate the model was written in APL (A Programming Language). The IRR computation was derived through an iterative loop which, in APL, can be costly due to the limitations of APL's capabilities (one run of 15 projects takes approximately 10 minutes, equating to a cost of nearly $80.00). Comparing the cost of computation to the benefits

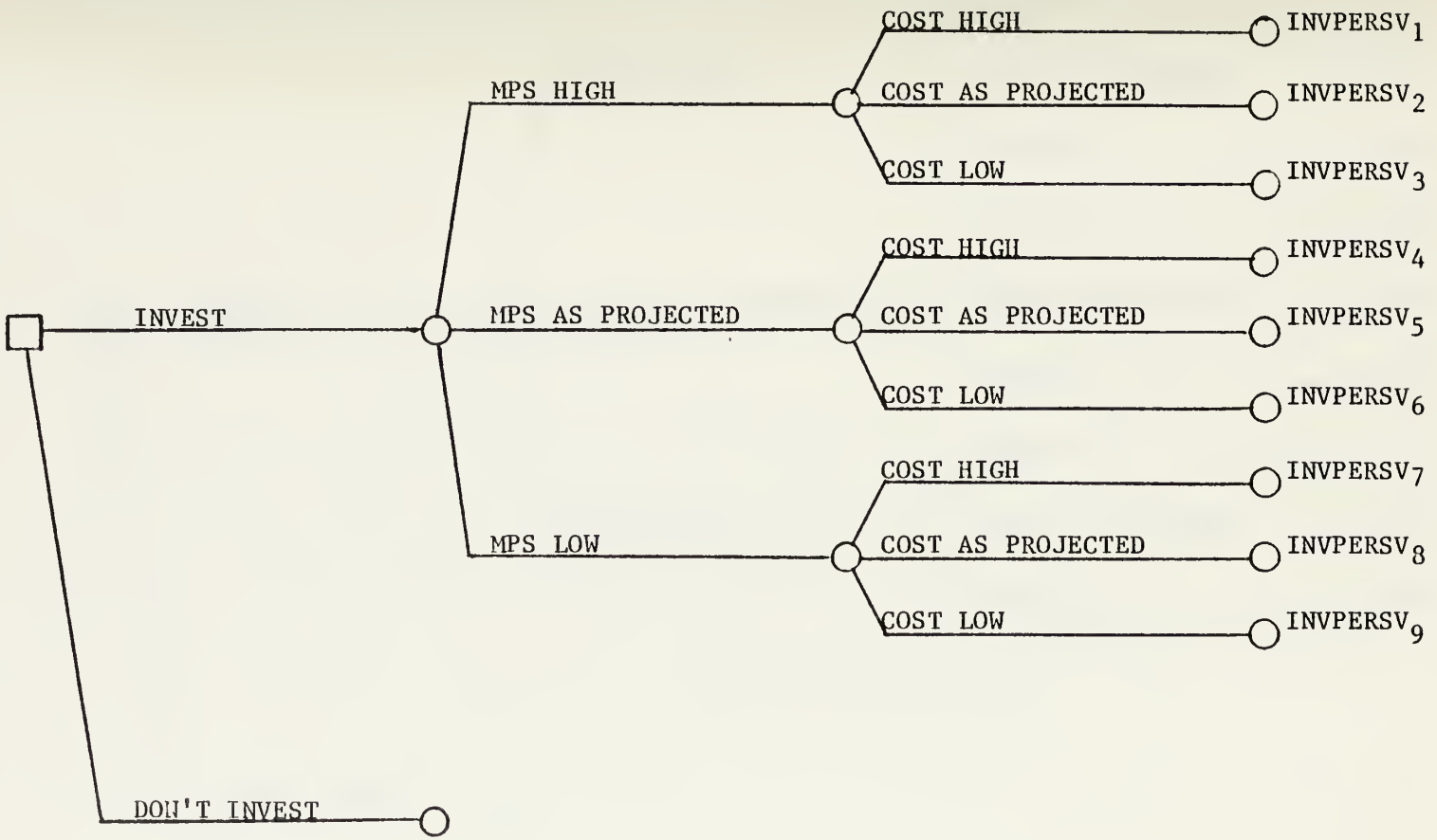

Figure 5. INVPERSV Submodel

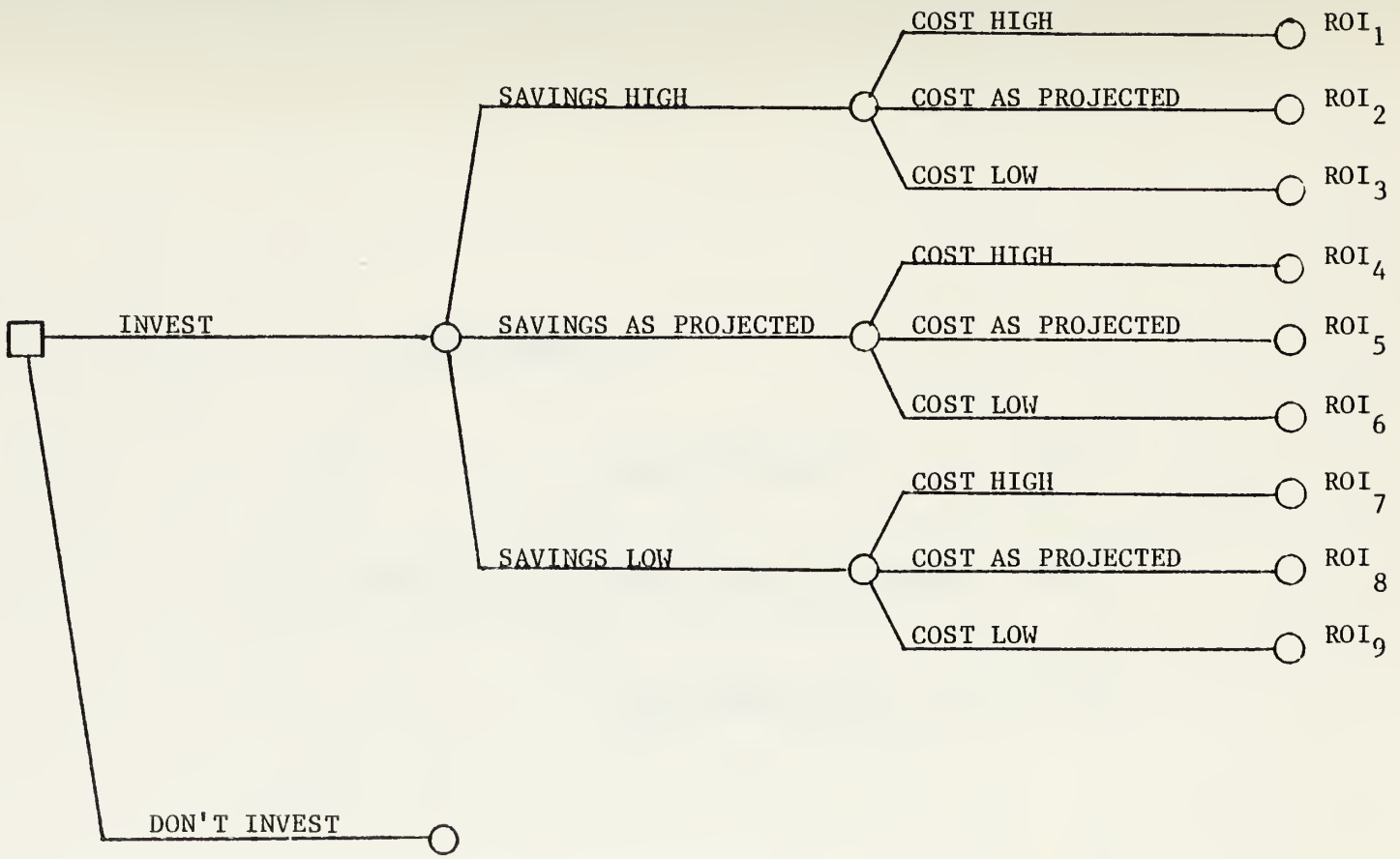

Figure 6. ROI Submodel

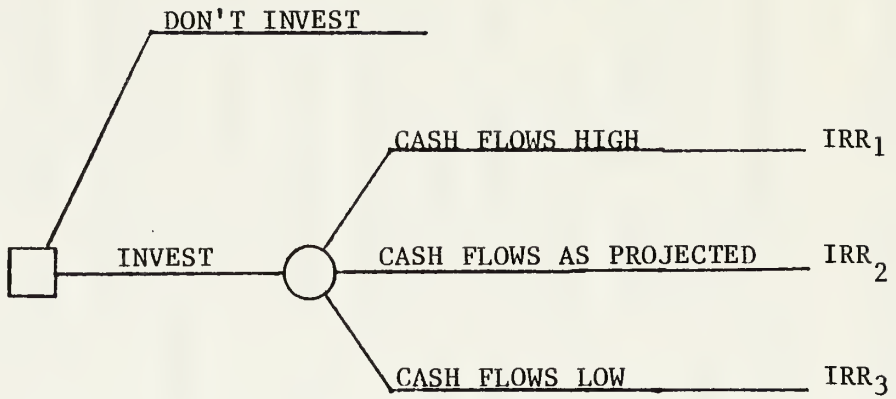

Figure 7. IRR Submodel

derived from the additional branching, it was felt that one branch was adequate.

As previously stated, the main model was broken down into three submodels, one for each indicator to be ranked. Once the program has computed the branch values in each submodel, it proceeds to apply the techniques that deal with uncertainty, in particular, the MAXIMIN, MAXIMAX and LaPlace principles.

The MAXIMIN principle may be viewed as a pessimistic approach. This principle of choice suggests that the maximum of the minimum gains be chosen, or select the best of the worst outcomes. In this section of the program, the minimum value of each submodel is selected and stored in three vectors (one for each indicator). These vectors are then placed in a 47[1] by 3 matrix where the rows represent projects and the columns are the respective indicators. A value in the matrix is the minimum value for an indicator peculiar to a project. Once this matrix is complete, each column (or indicator) is ranked from highest to lowest (i.e., the greatest number receives rank one, and so on). In the event of a tie, an average rank is used. These rankings are then placed in another matrix which will be referred to as the rank matrix. The ranks are then summed across the columns (indicators) and then re-ranked from lowest to highest. By summing across the columns, one is merely adding the ranks

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[1]There are 47 PIF projects funded in FY84. These projects form the data base.

of the indicators for each project. Subsequently, the project with the lowest combined rank is the best project and hence the reason to rank from the lowest (rank one) to the highest. The result of this procedure is a vector of 47 elements (one for each project) representing the final ranking.

The second technique used is the MAXIMAX principle. This is an optimistic approach where the best possible outcome is maximized. The procedure used here is identical to the MAXIMIN computation with the exception that the maximum value in each submodel is chosen instead of the minimum.

The LaPlace principle is computed somewhat differently. This method assumes that the branch values are equally likely to occur within each submodel. Using this probability distribution, an expected value for each indicator can be derived. The result is a matrix of expected values for each project and indicator. This matrix is then ranked using the same procedure as previously discussed.

The ultimate product of the program is a matrix of the final rankings of each product using each of the three methods of uncertainty. It is now possible to judge the effect of uncertainty by comparing these rankings to those derived using DPPO's procedure. However, before these results are revealed, some discussion on software support for the model and problems that arose during the development of the model warrant attention.

C. SOFTWARE SUPPORT

In the process of evaluating the model, two data files were created and several functions and programs written. The first file, THESISD, is a 47×5 matrix where the rows represent the projects and the columns are total cost, total savings, manpower spaces saved, NPV, and economic life. CFMATRIX is the second file containing the cash flows for each project over a period of 28 years. To ensure matrix conformability, zeroes had to be added to those projects whose economic lives were less than 28 years. These zeroes are removed in the main program to reduce computations.

The main program, UNCERT, is written in APL and calls its data from the two files. It internally computes ROI and INVPERSV branch values, selects max and min values and calls other functions for IRR values (CALIRR) and to perform rankings (RANKUP, RANKDN). A listing of UNCERT as well as the functions are contained in Appendix (A). Copies of the base data composes Appendix (B).

D. PROBLEM AREAS

In the development and documentation of the model, several problems were encountered which substantially altered the procedure to be used.

The first difficulty concerned itself with the INVPERSV computation. The formula used by DPPO can be expressed as

$$\text{INVPERSV} = \frac{\text{Total Cost}}{\text{Manpower Spaces Saved (MPS)}} . \qquad (6)$$

This presents two problems. First, if MPS is zero, INVPERSV is undefined (an MPS of zero is not uncommon). To correct this deficiency, DPPO arbitrarily sets INVPERSV equal to 9999.99. Secondly, if MPS is between zero and 1, then INVPERSV is greater than the total cost. Currently, there is no correction for this. Another difficulty with this indicator lies in its lack of logical attractiveness. Explicitly, IRR and ROI are benefits which implies bigger is better. INVPERSV, as presently used, is a cost (bigger is bad). Although the procedure used by DPPO takes this into account, it is felt that the indicator contradicts the logical flow when used with the other indicators.

A second problem arose when trying to duplicate DPPO's calculations of IRR. Using Equation (4) and assuming the cash inflows were present value (verified by DPPO to be correct), the IRR's obtained from CALIRR differed from those calculated by DPPO.

Another minor discrepancy involved the value for economic life. THESISD contained one value, however, when calculating IRR, different economic lives were obtained using the cash inflow information. This had no effect on calculations since IRR used strictly cash flow information.

Concern was additionally raised due to the fact that DPPO's final ranking could not be reproduced. Further discussions on this point are unnecessary since modifications to the analysis to be performed would create new rankings, thus eliminating any reason to duplicate the original ranked list.

E. PROCEDURE

At this point the reader should have an understanding of the model, how uncertainty will be introduced, and some problems that were encountered in the process. This section will: a) discuss how the INVPERSV problem was solved, b) explain how deviation levels were obtained, c) how the IRR confusion was treated and d) given an outline for sensitivity analysis that will be performed.

The first topic is how to correct the INVPERSV problem. If the original indicator yielded a cost, then the inverse of the indicator would be a benefit. Additionally, the inverse would also alleviate the problem of dividing by zero or a fraction. However, the inversion of the indicator results in a decimal. By scaling the result (multiply by 1000), the indicator becomes more readable and comparable to the other indicators. This transformation is given by:

$$\text{INVPERSV} = \left(\frac{\text{Total Manpower Spaces Saved}}{\text{Total Cost}}\right) \times 1000 \; . \qquad (7)$$

Take, for example, an INVPERSV of 275.0. The inverse would be 0.0036. Scaling by 1000 yields 3.6. Several things should be noted. First, using a scalar of 1000 is purely arbitrary. Any scalar could have been used. Secondly, by inverting the indicator, the ranking must be done from highest to lowest. This did not change the original ranking done by DPPO. The final point is that by inverting, the

logical attractiveness of INVPERSV is achieved. The reason for scaling is discussed more in Chapter VI but deals with an alternate means of obtaining a ranking.

In Section C, the idea of changing different variables (i.e., cost, savings, etc.) was introduced. How much to vary these variables is what is of interest here. In the program, deviation levels are represented as a vector with three elements. These elements represent variables above the projected level, as projected, and below projected levels. That is to say, if a cost overrun were to occur, the average overrun would be, for example, 20 percent of the projected cost. This can be mathematically expressed as, cost overrun = 1.2 × projected cost. Similarly, to maintain the projected cost, a multiplier of 1 is used while a number less than 1 would relate a cost underrun. Deviation levels can be determined by

$$\text{Cost Deviation} = \frac{\text{Actual Cost}}{\text{Projected Cost}} . \qquad (8)$$

By using Sciortino's [1] audit and Equation (8), deviation levels for cost, savings, and cash flows were obtained. Manpower variations, however, were purely subjective. In reviewing several audit reports, there is no data to address this point. The deviation levels used to obtain variations were 1.1 for a manpower overrun and 0.9 for an underrun. The sensitivity analysis that will be performed later will further address this area.

IRR fluctuations created an area of concern since they could not be duplicated and since the results obtained using Equation (4) showed no correlation to DPPO's data. To remedy the situation, all 47 projects were ranked using Equation (4) to calculate IRR and Equation (7) for INVPERSV (ROI calculations were the same). The results of this run will be referred to as the DPPO Base since this is what the rankings should have been with all problems aside. Next, a run was made to introduce uncertainty. These results were compared to the DPPO Base to see if any significant changes had taken place. For reference, Appendix (C) is the DPPO Base case and Appendix (D) displays the results after uncertainty was applied.

In order to examine which variables and uncertainty methods were critical, sensitivity analysis was performed. The variables of concern are cost, savings and manpower spaces saved. Initially, single variables were used, followed by changes in two variables and finally, by three. Appendix (E) contains the results of these runs while the next chapter discusses this issue in greater detail.

V. RESULTS

A. INITIAL COMPARISON

DPPO's ranking was computed using the new INVPERSV and IRR ranking. The base case, which introduces uncertainty into the ranking, was run using deviation levels outlined in Table I. These values were obtained using Sciortino's [1] audit and Equation (8). The output of the two runs were then compared to determine if the base case had any impact on DPPO's ranking.

TABLE I

Deviation Levels Used in the Base Case

	Above Projected	Below Projected
Cost	1.256	0.825
Savings/ Cash Flows	1.014	0.3116
Manpower Spaces	1.1	0.9

Before any comparison may be undertaken, it might be beneficial to define how this impact is to be measured. Three terms are used to judge the magnitude of difference between DPPO's ranking and the base case; 1) significant (S) implies that 5 or more projects experienced any rank jumps or any

two projects had jumps of 5 ranks or more, 2) slightly significant (SS) is defined as 3 or more projects had rank jumps or any two projects had jumps of three ranks or more, and 3) no significance (NS) merely represents any situation less than those described above.

Initially, all 47 projects were compared. This revealed that the MAXIMIN and LaPlace Principles significantly changed the rankings while the MAXIMAX showed little to no change. DPPO's rankings were divided into three groups; projects 1 through 15, 16 through 31 and 32 through 47. The reason for subdividing was to observe where the jumps in ranking occurred. A summary of the results is contained in Table II.

TABLE II

Summary of Initial Comparison

Project Number	MAXIMIN	LaPlace	MAXIMAX
All	S	S	NS
1-15	SS	NS	NS
16-31	S	SS	NS
32-47	S	S	NS

Using this information, it is evident that jumps occur more frequently in the lower projects. The reason for this occurrence is primarily due to the first 15 projects offering significantly greater IRRs, ROIs, and INVPERSVs than the

others. This information will play a role in performing sensitivity analysis and therefore the discussion will be delayed until then.

B. SENSITIVITY ANALYSIS

Due to cost constraints in running all 47 projects, only the first 15 were used to perform sensitivity analysis. To begin, a new base case dealing with uncertainty was derived and would be used to compare 24 variant runs. The purpose of this analysis was to determine which variables were critical and which uncertainty methods were sensitive to the changes. First, single variable deviations were analyzed, followed by two and three variable combinations.

The results of the initial runs with single variables indicated that all three methods were insensitive to minor changes in the variables with one exception. This run dealt with increasing the bounds (above projected and below projected deviation levels) of savings by 20 percent and creating significant rank jumps in the MAXIMIN ranking and slightly significant jumps in that of LaPlace.

The deviation levels were then preset to values outlined in Table III. It should be noted that these levels are substantial deviations from the projected values. This is primarily due to the nature of the first 15 projects. As mentioned in Section A of this chapter, the initial comparison noted little change in ranking among the three methods. This is attributable to the large variations in each of the

TABLE III

Deviation Levels Used in Sensitivity Analysis

	Above Projected	Below Projected
Cost	2.512	0.2
Savings/ Cash Flows	2.0	0.1
Manpower Spaces	2.2	0.2

variables in the first 15 projects as compared to the rest. These variations are presented in Table IV. Due to restrictions in programming, other projects could not have been selectively chosen without redrafting files. However, despite this problem, it is still possible to determine critical variables and sensitive methods.

Table V conveniently summarizes the results obtained from the analysis. A word on notation though, might aid in its understanding. In the description column, the variable being changed is described as being either high or low. High refers to an increase in the above projected deviation level only while low, decreases the below projected level. Run 2b decreased both bounds by a set percent and Run 3b increased both bounds. As stated earlier, other runs utilizing this procedure yielded no changes with the exception of 3b and, therefore, eliminated further use of the procedure.

To further summarize the contents of Table V, it can be said that the LaPlace principle was the most sensitive to

TABLE IV

Statistical Summary of Projects

Project Number	Cost		Savings		Manpower Spaces		Economic Life	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
All	1603.6	3717.4	22701	45826	50.211	143.260	12.404	7.0669
1-15	3500.2	6072.2	52358	72045	96.400	187.150	14.267	8.5979
16-31	464.2	483.0	8565	13117	8.288	17.762	11.625	4.9929
32-47	965.1	1519.6	9034	11474	48.831	161.02	11.438	4.9929

TABLE V

Summary of Sensitivity Analysis

Run Number	Description	MAXIMIN	LAPLACE	MAXIMAX
1	Cost High	NS	NS	NS
2a	Cost Low	S	SS	NS
2b	Cost Low	NS	NS	NS
3a	Savings High	NS	SS	NS
3b	savings High	S	SS	NS
4	Savings Low	S	SS	NS
5	MPS High	NS	NS	NS
6	MPS Low	NS	NS	NS
7	Cost High - Savings High	NS	SS	NS
8	Cost High - Savings Low	SS	SS	NS
9	Cost Low - Savings High	NS	SS	NS
10	Cost Low - Savings Low	S	SS	NS
11	Cost High - MPS High	NS	NS	NS
12	Cost High - MPS Low	NS	NS	NS
13	Cost Low - MPS High	NS	NS	NS
14	Cost Low - MPS Low	NS	NS	NS
15	Savings High - MPS High	NS	SS	NS
16	Savings High - MPS Low	NS	SS	NS
17	Savings Low - MPS High	SS	SS	NS
18	Savings Low - MPS Low	SS	SS	NS
19	Cost Low-Savings High-MPS High	S	SS	NS
20	Cost Low-Savings High-MPS Low	S	SS	NS
21	Cost High-Savings Low-MPS High	NS	SS	NS
22	Cost High-Savings Low-MPS Low	NS	SS	NS

NS - Not Significant
SS - Slightly Significant
S - Significant

change. This may be attributed to the cost-savings relationship and, in particular, savings deviations. This would affect both the ROI and IRR. The method was insensitive to manpower variations. The only other method to show a reaction was MAXIMIN. This is strongly evident in low savings cases. Low savings (implying low cash flows) will, in turn, drive IRR with an additional effect on ROI. Once again, manpower fluctuations had little to no effect. The last principle, MAXIMAX showed little to no change during the course of the analysis.

To summarize, the LaPlace principle showed sensitivity to more variables or combinations thereof. The MAXIMIN method was the only technique to cause significant jumps in rankings. With both methods, savings seemed to be the critical variable indicating that IRR is the main driver in the rankings, followed by ROI. INVPERSV had little to no effect in the rankings.

VI. CONCLUSIONS AND REMARKS

A. CONCLUSIONS

Since the objective of this thesis was to determine if the methods of risk and uncertainty could change project rankings from the present procedure, this point shall be addressed first. It is apparent that both the MAXIMIN and LaPlace principles will change the ranking and their incorporation into the present procedure should be investigated as a short term solution. Additionally, the LaPlace approach is recommended above the others for several reasons: It is not an extreme selection; it makes more use of the different outcomes than the other methods; and it is more sensitive to the variables and combinations thereof.

This paper does not purport to advocate strict adherence to methods of uncertainty in decision making. The use of risk is a better solution to solving problems of this nature. To enable the use of risk techniques, it is recommended that audit reports compare realized costs, savings, and manpower to that which was projected. Furthermore, since DPPO maintains a data base from which the projects are ranked, this data base should also serve as a reference in doing audits. As mentioned before, audit reports should also address manpower spaces, which to this point, has gone without remark.

The use of the new INVPERSV and IRR equation have been discussed sufficiently. Their incorporation into the present procedure is highly recommended.

The use of equal weights for the indicators is another questionable area, and will be addressed in the final section of this chapter.

Although more conclusions could be drawn, the next section will introduce a corrective procedure which would provide better and more accurate rankings.

B. REMARKS

The content of this thesis introduced the use of risk and uncertainty into DPPO's procedure. This is what it was commissioned to do; however, a better approach utilizing multiattribute utility theory may prove to provide quite different results.

The present procedure has several flaws. The first is using linear combinations of rankings to obtain a final aggregate ranking. Economic indicators are measures of effectiveness (MOEs). These MOEs have a common origin (zero) and are measured on a ratio scale, meaning a statement may be made to the effect that one IRR is twice as good as another IRR.

The use of ranks, changes the scale to ordinal and this information is lost. An example may best illustrate this point. Suppose a comparison of projects A and B is to be made. Project A has an IRR of 200 percent, an ROI of 87

percent and an INVPERSV of 78. Project B, on the other hand, has an IRR of 25 percent, an ROI of 88 percent and an INVPERSV of 79. According to the present procedure, project B is better. However, if a ratio scale is used, then project A would be the wiser choice since A's IRR is 8 times greater than B's with the other indicators about equal.

Additionally, the sensitivity analysis pointed out that IRR seemed to drive the rankings with ROI having a smaller input. This indicates that the use of equal weights may not be as reasonable as initially thought.

This topic should be considered an area for future study. The benefits derived from it could be substantial and lead to a more effective manner to judge projects and eventually realize their benefits.

APPENDIX A

SOFTWARE SUPPORT

This appendix contains the programs used to introduce uncertainty to the Productivity Investment Fund.

```
      ∇ UNCERT
[1]    'RUN NUMBER: DPPO BASE'
[2]   ⍝
[3]   ⍝   INPUT DEVIATION LEVELS
[4]   ⍝
[5]    COSTD←1
[6]    SAVD←1
[7]    CFD←1
[8]    MPSD←1
[9]   ⍝
[10]   'DEVIATION LEVELS:'
[11]   '   COST       :',⍕COSTD
[12]   '   SAVINGS    :',⍕SAVD
[13]   '   MANPOWER   :',⍕MPSD
[14]   '   CASHFLOWS:',⍕CFD
[15]   '          '
[16]   □←'INPUT TOTAL NO OF PROJECTS TO BE RANKED.'
[17]   TN←□
[18]   I←0
[19]   MAXIRR←MAXROI←MAXMPS←LROI←LMPS←0×(⍳TN)
[20]   MINIRR←MINROI←MINMPS←9999×1+0×⍳TN
[21]   LIRR←LROI←LMPS←0×⍳TN
[22]  L1:I←I+1
[23]  ⍝   INSERT DATA
[24]   COST←,THESISD[I;1]
[25]   SAV←,THESISD[I;2]
[26]   MPS←,THESISD[I;3]
[27]   NPV←,THESISD[I;4]
[28]   CF←,CFMATRIX[I;]
[29]  ⍝
[30]   '          '
[31]   'PROJECT NUMBER:',⍕I
[32]   '          '
[33]   'INPUT VARIABLES:'
[34]   '   TOTAL COST     :',⍕COST
[35]   '   TOTAL SAVINGS  :',⍕SAV
[36]   '   MANPOWER SAVED:',⍕MPS
[37]  ⍝
[38]  ⍝    DELETE 0'S FROM CF VECTOR
[39]  ⍝
[40]   CF←DROP CF
[41]   '   CASH FLOWS     :',⍕CF
[42]   '          '
[43]   '       '
[44]  ⍝
[45]  ⍝    COMPUTE BRANCH VALUES
[46]  ⍝
[47]   COSTS←COST×COSTD
[48]   SAVS←SAV×SAVD
[49]   MPSS←MPS×MPSD
[50]   COUNT←⍴COSTS
[51]  ⍝
[52]  ⍝   SELECT THE VALUES FOR EACH OF THE PROJECTS
[53]   '     ROI     MPS'
[54]  ⍝
[55]   EROI←EMPS←0×⍳9
[56]   J←L←0
[57]  L2:J←J+1
[58]   K←0
[59]  L3:K←K+1
[60]   L←L+1
[61]   EROI[L]←SAVS[J]÷COSTS[K]
[62]   EMPS[L]←(MPSS[J]÷COSTS[K])×1000
[63]   EROI[L] AND EMPS[L]
[64]   →(K<COUNT)/L3
[65]   →(J<COUNT)/L2
[66]  ⍝
[67]  ⍝   COMPUTE IRR VALUES
[68]  ⍝
[69]   '       '
```

```
[70]   '      '
[71]   CALIRR CF
[72]  ⍝
[73]  ⍝   APPLY LAPLACE METHOD
[74]  ⍝
[75]   LROI[I]←LAPLACE EROI
[76]   LMPS[I]←LAPLACE EMPS
[77]   LIRR[I]←LAPLACE EIRR
[78]  ⍝
[79]   '      '
[80]   'LAPLACE VALUES FOR ROI IRR AND MPS'
[81]   LROI[I] AND LIRR[I] AND LMPS[I]
[82]  ⍝   SELECT MAX AND MIN
[83]  ⍝
[84]   MAXROI[I]←(⌈/EROI)
[85]   MAXIRR[I]←(⌈/EIRR)
[86]   MAXMPS[I]←(⌈/EMPS)
[87]   MINROI[I]←(⌊/EROI)
[88]   MINIRR[I]←(⌊/EIRR)
[89]   MINMPS[I]←(⌊/EMPS)
[90]   →(I<TN)/L1
[91]   '      '
[92]   '   MAXROI   MINROI    MAXIRR   MINIRR   MAXMPS   MINMPS'
[93]   MAXROI AND MINROI AND MAXIRR AND MINIRR AND MAXMPS AND MINMPS
[94]  ⍝
[95]  ⍝    RANK THE INDICATORS
[96]  ⍝
[97]  ⍝    APPLY MAXIMIN CRITERIA
[98]   RANK1←RANKUP MINROI
[99]   RANK2←RANKUP MINMPS
[100]   RANK3←RANKUP MINIRR
[101]   MATRIX1←RANK1 AND RANK2 AND RANK3
[102]   FINAL1←+/MATRIX1
[103]   FINRANK1←RANKDN FINAL1
[104]  ⍝
[105]   NO←⍳TN
[106]  ⍝
[107]   RANK4←RANKUP LROI
[108]   RANK5←RANKUP LMPS
[109]   RANK6←RANKUP LIRR
[110]   MATRIX2←RANK4 AND RANK5 AND RANK6
[111]   FINAL2←+/MATRIX2
[112]   FINRANK2←RANKDN FINAL2
[113]  ⍝
[114]   RANK7←RANKUP MAXROI
[115]   RANK8←RANKUP MAXMPS
[116]   RANK9←RANKUP MAXIRR
[117]   MATRIX3←RANK7 AND RANK8 AND RANK9
[118]   FINAL3←+/MATRIX3
[119]   FINRANK3←RANKDN FINAL3
[120]  ⍝
[121]   '      '
[122]   'THE FINAL RANKINGS LISTED BY METHOD:'
[123]   'PROJ MAXIMIN LAPLACE MAXIMAX'
[124]   NO AND FINRANK1 AND FINRANK2 AND FINRANK3
        ∇
```

```
      ∇CALIRR[0]
      ∇ Z←CALIRR X
[1]   LIMIT←0.01×COST
[2]   EIRR←0×⍳3
[3]   ELIFE←⍴X
[4]   CAL←0×(⍳ELIFE)
[5]   'IRR VALUES:'
[6]   II←0
[7]  L1:II←II+1
[8]   JJ←0
[9]   R←0.3
[10]  CFS←X×CFD[II]
[11] L2:R←R+0.001
[12]  JJ←0
[13] L3:JJ←JJ+1
[14]  CAL[JJ]←CFS[JJ]÷((1+R)*JJ)
[15]  →(JJ<ELIFE)/L3
[16]  ANS←+/CAL
[17]  CALSUM←ANS-COST
[18]  UPPER←CALSUM+LIMIT
[19]  LOWER←CALSUM-LIMIT
[20]  →((LOWER≤0)∧(UPPER≥0))/L4
[21]  →(CALSUM≥0)/L2
[22]  R←(R-0.105)
[23]  →L2
[24] L4:EIRR[II]←R
[25]  EIRR[II]
[26]  →(II<3)/L1
      ∇
```

```
∇CONVERT[0]∇
      ∇ Z←CONVERT X
[1]   COST←,THESISD[;1]
[2]   IND←0×⍳47
[3]   I←0
[4]  L1:I←I+1
[5]   IND[I]←X[I]÷COST[I]
[6]   →(I<47)/L1
      ∇
```

```
      ∇LAPLACE[0]∇
      ∇ Z←LAPLACE X
[1]   INDEX←⍴X
[2]   P←1÷INDEX
[3]   AVG←+/(VAL←X×P)
[4]   Z←AVG
      ∇
```

```
      ∇RANKUP[⎕]∇
      ∇ Z←RANKUP X
[1]     Y←X[⍋X]
[2]     INDEX←⍴Y
[3]     I←0
[4]     ANS←R←0×⍳⍴Y
[5]   L1:I←I+1
[6]     J←0
[7]   L2:J←J+1
[8]     ANS[J]←(X[I]=Y[J])
[9]     →(J<INDEX)/L2
[10]    DUP←+/ANS
[11]    →(DUP>1)/L3
[12]    R[I]←ANS⍳1
[13]    →(I<INDEX)/L1
[14]    →L99
[15]  L3:XX←⌈/T←+\ANS
[16]    YY←⍳XX
[17]    F←0×⍳XX
[18]    L←0
[19]  L4:L←L+1
[20]    F[L]←T⍳L
[21]    →(L<XX)/L4
[22]    RT←+/F÷⍴F
[23]    R[I]←RT
[24]    →(I<INDEX)/L1
[25]  L99:Z←R
```

```
      ∇
∇DROP[⎕]∇
      ∇ Z←DROP X
[1]     Y←4↑X
[2]     Z←4↓X
[3]     INDEX←(Z≠0)
[4]     XX←INDEX/Z
[5]     Z←Y,XX
      ∇
```

APPENDIX B

DPPO'S DATA FILE

This appendix contains the data used to perform the analysis.

Project No	Total Cost	Total Savings	Manpower Saved	NPV	Economic Life
1	572.5	25445.0	9.0	16706.3	5
2	21178.4	154800.0	472.0	72663.3	8
3	5542.2	130072.5	272.0	33482.7	25
4	268.0	6151.0	4.0	3886.3	5
5	629.9	16255.0	0.0	4247.0	25
6	1033.8	5016.7	52.6	2137.9	7
7	784.2	20067.5	0.0	5838.7	25
8	1026.4	28292.5	0.0	8311.0	25
9	1711.7	27529.6	0.0	8820.0	20
10	468.8	2531.0	38.9	1450.0	5
11	14345.0	253374.1	573.0	126215.9	8
12	1894.0	37600.0	0.0	19107.9	10
13	788.5	9198.0	7.0	2770.6	20
14	240.0	3828.0	3.0	1241.2	20
15	2020.0	65214.1	14.5	39210.2	6
16	147.7	1499.0	5.0	689.6	10
17	138.7	1873.5	0.0	1041.7	10
18	126.0	1757.2	0.6	966.2	8
19	245.2	1314.4	5.0	568.7	10
20	1871.7	52637.2	0.0	15621.3	28
21	535.3	5863.0	0.0	3067.0	10
22	476.2	5301.1	0.0	2876.9	7
23	161.6	1774.5	12.0	1183.7	5
24	135.0	10557.5	0.0	3697.8	25
25	290.0	1421.0	16.0	609.8	7
26	420.0	8763.0	0.0	4964.2	10
27	1351.8	14999.1	72.0	9803.3	5
28	616.9	21710.0	0.0	7264.6	25
29	363.9	2647.7	11.4	1217.4	10
30	370.0	3439.7	7.6	1866.2	8
31	177.0	1480.0	3.0	809.9	8
32	173.1	1897.0	1.8	502.5	25
33	861.3	8366.0	13.7	3811.6	10
34	520.0	12789.0	1.5	5964.4	15
35	908.0	7200.0	6.0	3456.7	8
36	298.7	2361.6	18.0	1276.1	8
37	935.0	6700.0	44.4	3411.6	8
38	199.0	2460.0	2.0	1301.9	10
39	635.0	4768.0	15.0	2544.4	8
40	143.3	940.8	3.3	427.0	8
41	262.0	12060.0	0.3	5296.9	15
42	5931.5	23260.9	651.2	12142.0	8
43	3182.0	45950.0	4.0	21875.3	10
44	870.0	9427.4	13.6	3854.6	12
45	121.0	672.0	2.0	327.1	8
46	105.8	828.0	2.5	246.6	20
47	294.9	4857.0	2.0	2418.0	10

Summary of Cash Inflows for Each Project for 28 Years

Year	Project Number									
	1	2	3	4	5	6	7	8	9	10
1	3585	19350	0	957	0	716.7	802.7	1131.7	1115.8	506.2
2	5465	19350	5202.9	1044.5	650.2	716.7	802.7	1131.7	1390.2	506.2
3	5465	19350	5202.9	1322.5	650.2	716.7	802.7	1131.7	1390.2	506.2
4	5465	19350	5202.9	1413.5	650.2	716.7	802.7	1131.7	1390.2	506.2
5	5465	19350	5202.9	1413.5	650.2	716.7	802.7	1131.7	1390.2	506.2
6	0	19350	5202.9	0	650.2	716.7	802.7	1131.7	1390.2	0
7	0	19350	5202.9	0	650.2	716.7	802.7	1131.7	1390.2	0
8	0	19350	5202.9	0	650.2	716.5	802.7	1131.7	1390.2	0
9	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
10	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
11	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
12	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
13	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
14	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
15	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
16	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
17	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
18	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
19	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
20	0	0	5202.9	0	650.2	0	802.7	1131.7	1390.2	0
21	0	0	5202.9	0	650.2	0	802.7	1131.7	0	0
22	0	0	5202.9	0	650.2	0	802.7	1131.7	0	0
23	0	0	5202.9	0	650.2	0	802.7	1131.7	0	0
24	0	0	5202.9	0	650.2	0	802.7	1131.7	0	0
25	0	0	5202.9	0	650.2	0	802.7	1131.7	0	0
26	0	0	5202.9	0	0	0	0	0	0	0
27	0	0	5202.9	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0

Cash Inflows (Con't)

Year	Project Number									
	11	12	13	14	15	16	17	18	19	20
1	33912.2	3760	459.9	191.4	9316.3	149.9	143.5	89.2	150.7	1879.9
2	31351.7	3760	459.9	191.4	9316.3	149.9	219.5	208.5	129.3	1879.9
3	31351.7	3760	459.9	191.4	9316.3	149.9	217.5	208.5	129.3	1879.9
4	31351.7	3760	459.9	191.4	9316.3	149.9	215.5	208.5	129.3	1879.9
5	31351.7	3760	459.9	191.4	9316.3	149.9	215.5	208.5	129.3	1879.9
6	31351.7	3760	459.9	191.4	9316.3	149.9	215.5	208.5	129.3	1879.9
7	31351.7	3760	459.9	191.4	9316.3	149.9	215.5	208.5	129.3	1879.9
8	31351.7	3760	459.9	191.4	0	149.9	215.5	208.5	129.3	1879.9
9	0	3760	459.9	191.4	0	149.9	215.5	208.5	129.3	1879.9
10	0	3760	459.9	191.4	0	149.9	0	0	129.3	1879.9
11	0	0	459.9	191.4	0	0	0	0	0	1879.9
12	0	0	459.9	191.4	0	0	0	0	0	1879.9
13	0	0	459.9	191.4	0	0	0	0	0	1879.9
14	0	0	459.9	191.4	0	0	0	0	0	1879.9
15	0	0	459.9	191.4	0	0	0	0	0	1879.9
16	0	0	459.9	191.4	0	0	0	0	0	1879.9
17	0	0	459.9	191.4	0	0	0	0	0	1879.9
18	0	0	459.9	191.4	0	0	0	0	0	1879.9
19	0	0	459.9	191.4	0	0	0	0	0	1879.9
20	0	0	459.9	191.4	0	0	0	0	0	1879.9
21	0	0	0	0	0	0	0	0	0	1879.9
22	0	0	0	0	0	0	0	0	0	1879.9
23	0	0	0	0	0	0	0	0	0	1879.9
24	0	0	0	0	0	0	0	0	0	1879.9
25	0	0	0	0	0	0	0	0	0	1879.9
26	0	0	0	0	0	0	0	0	0	1879.9
27	0	0	0	0	0	0	0	0	0	1879.9
28	0	0	0	0	0	0	0	0	0	1879.9

Cash Inflows (Con't)

Year	Project Number									
	21	22	23	24	25	26	27	28	29	30
1	586.3	764.5	354.9	422.3	209	876.3	2249.9	868.4	125.9	356.5
2	586.3	756.1	354.9	422.3	202	876.3	2999.8	868.4	280.2	367.4
3	586.3	756.1	354.9	422.3	202	876.3	2999.8	868.4	280.2	389.3
4	586.3	756.1	354.9	422.3	202	876.3	2999.8	868.4	280.2	412.8
5	586.3	756.1	354.9	422.3	202	876.3	3749.8	868.4	280.2	437.5
6	586.3	756.1	0	422.3	202	876.3	0	868.4	280.2	463.7
7	586.3	756.1	0	422.3	202	876.3	0	868.4	280.2	491.5
8	586.3	0	0	422.3	0	876.3	0	868.4	280.2	521
9	586.3	0	0	422.3	0	876.3	0	868.4	280.2	0
10	586.3	0	0	422.3	0	876.3	0	868.4	280.2	0
11	0	0	0	422.3	0	0	0	868.4	0	0
12	0	0	0	422.3	0	0	0	868.4	0	0
13	0	0	0	422.3	0	0	0	868.4	0	0
14	0	0	0	422.3	0	0	0	868.4	0	0
15	0	0	0	422.3	0	0	0	868.4	0	0
16	0	0	0	422.3	0	0	0	868.4	0	0
17	0	0	0	422.3	0	0	0	868.4	0	0
18	0	0	0	422.3	0	0	0	868.4	0	0
19	0	0	0	422.3	0	0	0	868.4	0	0
20	0	0	0	422.3	0	0	0	868.4	0	0
21	0	0	0	422.3	0	0	0	868.4	0	0
22	0	0	0	422.3	0	0	0	868.4	0	0
23	0	0	0	422.3	0	0	0	868.4	0	0
24	0	0	0	422.3	0	0	0	868.4	0	0
25	0	0	0	422.3	0	0	0	868.4	0	0
26	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0

Cash Inflows (Con't)

Year	Project Number									
	31	32	33	34	35	36	37	38	39	40
1	185	86.2	836.6	852.6	900	295.2	400	225	596	117.6
2	185	86.2	836.6	852.6	900	295.2	900	235	596	117.6
3	185	86.2	836.6	852.6	900	295.2	900	250	596	117.6
4	185	86.2	836.6	852.6	900	295.2	900	250	596	117.6
5	185	86.2	836.6	852.6	900	295.2	900	250	596	117.6
6	185	86.2	836.6	852.6	900	295.2	900	250	596	117.6
7	185	86.2	836.6	852.6	900	295.2	900	250	596	117.6
8	185	0.2	836.6	852.6	900	295.2	900	250	596	117.6
9	0	0.2	836.6	852.6	0	0	0	250	0	0
10	0	86.2	836.6	852.6	0	0	0	250	0	0
11	0	0.2	0	852.6	0	0	0	0	0	0
12	0	86.2	0	852.6	0	0	0	0	0	0
13	0	86.2	0	852.6	0	0	0	0	0	0
14	0	86.2	0	852.6	0	0	0	0	0	0
15	0	86.2	0	852.6	0	0	0	0	0	0
16	0	86.2	0	0	0	0	0	0	0	0
17	0	86.2	0	0	0	0	0	0	0	0
18	0	86.2	0	0	0	0	0	0	0	0
19	0	86.2	0	0	0	0	0	0	0	0
20	0	86.2	0	0	0	0	0	0	0	0
21	0	86.2	0	0	0	0	0	0	0	0
22	0	86.2	0	0	0	0	0	0	0	0
23	0	86.2	0	0	0	0	0	0	0	0
24	0	86.2	0	0	0	0	0	0	0	0
25	0	86.2	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0

Cash Inflows (Con't)

Year	Project Number						
	41	42	43	44	45	46	47
1	804	4788.5	500	541.9	84	41.4	485.7
2	804	6226	1000	604.5	84	41.4	485.7
3	804	3987.7	2030	828.1	84	41.4	485.7
4	804	3987.8	6060	828.1	84	41.4	485.7
5	804	1067.7	6060	828.1	84	41.4	485.7
6	804	1067.7	6060	828.1	84	41.4	485.7
7	804	1067.7	6060	828.1	84	41.4	485.7
8	804	1067.7	6060	828.1	84	41.4	485.7
9	804	0	6060	828.1	0	41.4	485.7
10	804	0	6060	828.1	0	41.4	485.7
11	804	0	0	828.1	0	41.4	0
12	804	0	0	828.1	0	41.4	0
13	804	0	0	0	0	41.4	0
14	804	0	0	0	0	41.4	0
15	804	0	0	0	0	41.4	0
16	0	0	0	0	0	41.4	0
17	0	0	0	0	0	41.4	0
18	0	0	0	0	0	41.4	0
19	0	0	0	0	0	41.4	0
20	0	0	0	0	0	41.4	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0

APPENDIX C

DPPO'S DATA BASE

This appendix contains the results from the DPPO Base case.

```
RUN NUMBER: DPPO BASE CASE

DEVIATION LEVELS:
  COST      :1
  SAVINGS   :1 1 1
  MANPOWER  :1
  CASHFLOWS:1 1 1


PROJECT NUMBER:1

INPUT VARIABLES:
  TOTAL COST     :572.5
  TOTAL SAVINGS  :25445
  MANPOWER SAVED:9
  CASH FLOWS     :3585 5465 5465 5465 5465

LAPLACE VALUES FOR ROI IRR AND MPS
 4.9384 6.626  1.7467


PROJECT NUMBER:2

INPUT VARIABLES:
  TOTAL COST     :21178
  TOTAL SAVINGS  :1.548E5
  MANPOWER SAVED:472
  CASH FLOWS     :19350  19350 19350  19350 19350 19350 19350 19350

LAPLACE VALUES FOR ROI IRR AND MPS
 0.81215 0.9      2.4763
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:3

INPUT VARIABLES:
  TOTAL COST     :5542.2
  TOTAL SAVINGS  :1.3007E5
  MANPOWER SAVED:272
  CASH FLOWS     :0 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202
      .9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9
     5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9

LAPLACE VALUES FCR ROI IRR AND MPS
 2.6077 0.587  5.4531


PROJECT NUMBER:4

INPUT VARIABLES:
  TOTAL COST     :268
  TOTAL SAVINGS  :6151
  MANPOWER SAVED:4
  CASH FLOWS     :957 1044.5  1322.5  1413.5 1413.5

LAPLACE VALUES FCR ROI IRR AND MPS
 2.5502 3.654  1.6584


PROJECT NUMBER:5

INPUT VARIABLES:
  TOTAL COST     :629.9
  TOTAL SAVINGS  :16255
  MANPOWER SAVED:0
  CASH FLOWS     :0 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2
     650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 6
     50.2 650.2

LAPLACE VALUES FCR ROI IRR AND MPS
 2.8673 0.628  0
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:6

INPUT VARIABLES:
  TOTAL COST     :1033.8
  TOTAL SAVINGS  :5016.7
  MANPOWER SAVED:52.6
  CASH FLOWS     :716.7 716.7 716.7 716.7 716.7 716.7 716.7 716.5

LAPLACE VALUES FOR ROI IRR AND MPS
 0.53919 0.676   5.6534


PROJECT NUMBER:7

INPUT VARIABLES:
  TOTAL COST     :784.2
  TOTAL SAVINGS  :20068
  MANPOWER SAVED:0
  CASH FLOWS     :802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 80
      2.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802
      .7 802.7 802.7

LAPLACE VALUES FOR ROI IRR AND MPS
 2.8433 1.014  0


PROJECT NUMBER:8

INPUT VARIABLES:
  TOTAL COST     :1026.4
  TOTAL SAVINGS  :28293
  MANPOWER SAVED:0
  CASH FLOWS     :1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7
      1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 11
      31.7 1131.7 1131.7 1131.7 1131.7 1131.7

LAPLACE VALUES FOR ROI IRR AND MPS
 3.0628 1.092  0
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:9

INPUT VARIABLES:
  TOTAL COST     :1711.7
  TOTAL SAVINGS  :27530
  MANPOWER SAVED:0
  CASH FLOWS     :1115.8 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2
       1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 13
      90.2

LAPLACE VALUES FCR ROI IRR AND MPS
 1.787 0.737 0


PROJECT NUMBER:10

INPUT VARIABLES:
  TOTAL COST     :468.8
  TOTAL SAVINGS  :2531
  MANPOWER SAVED:38.9
  CASH FLOWS     :506.2 506.2 506.2 506.2 506.2

LAPLACE VALUES FCR ROI IRR AND MPS
 0.59988 1.039   9.2198


PROJECT NUMBER:11

INPUT VARIABLES:
  TOTAL COST     :14345
  TOTAL SAVINGS  :2.5337E5
  MANPOWER SAVED:573
  CASH FLOWS     :33912 31352 31352 31352 31352 31352 31352 31352

LAPLACE VALUES FCR ROI IRR AND MPS
 1.9625 2.287  4.4382
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:12

INPUT VARIABLES:
  TOTAL COST     :1894
  TOTAL SAVINGS  :37600
  MANPOWER SAVED:0
  CASH FLOWS     :3760 3760 3760 3760 3760 3760 3760 3760 3760 3760

LAPLACE VALUES FOR ROI IRR AND MPS
 2.2058 1.966  0


PROJECT NUMBER:13

INPUT VARIABLES:
  TOTAL COST     :788.5
  TOTAL SAVINGS  :9198
  MANPOWER SAVED:7
  CASH FLOWS     :459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 45
      9.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9

LAPLACE VALUES FOR ROI IRR AND MPS
 1.2961 0.578  0.9864


PROJECT NUMBER:14

INPUT VARIABLES:
  TOTAL COST     :240
  TOTAL SAVINGS  :3828
  MANPOWER SAVED:3
  CASH FLOWS     :191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 19
      1.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4

LAPLACE VALUES FOR ROI IRR AND MPS
 1.7722 0.79   1.3889
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:15

INPUT VARIABLES:
  TOTAL COST     :2020
  TOTAL SAVINGS  :65214
  MANPOWER SAVED:14.5
  CASH FLOWS     :9316.3 9316.3 9316.3 9316.3 9316.3 9316.3 9316.3

LAPLACE VALUES FOR ROI IRR AND MPS
 3.5871  4.567   0.79758


PROJECT NUMBER:16

INPUT VARIABLES:
  TOTAL COST     :147.7
  TOTAL SAVINGS  :1499
  MANPOWER SAVED:5
  CASH FLOWS     :149.9 149.9 149.9 149.9 149.9 149.9 149.9 149.9 149.9 149.9

LAPLACE VALUES FCR ROI IRR AND MPS
 1.1277 1.004  3.7614


PROJECT NUMBER:17

INPUT VARIABLES:
  TOTAL COST     :138.7
  TOTAL SAVINGS  :1873.5
  MANPOWER SAVED:0
  CASH FLOWS     :143.5 219.5 217.5 215.5 215.5 215.5 215.5 215.5 215.5

LAPLACE VALUES FCR ROI IRR AND MPS
 1.5008 1.26   0
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:18

INPUT VARIABLES:
  TOTAL COST      :126
  TOTAL SAVINGS :1757.2
  MANPOWER SAVED:0.6
  CASH FLOWS      :89.2 208.5 208.5 208.5 208.5 208.5 208.5 208.5 208.5

LAPLACE VALUES FCR ROI IRR AND MPS
 1.5496 1.138  0.5291


PROJECT NUMBER:19

INPUT VARIABLES:
  TOTAL COST      :245.2
  TOTAL SAVINGS :1314.4
  MANPOWER SAVED:5
  CASH FLOWS      :150.7 129.3 129.3 129.3 129.3 129.3 129.3 129.3 129.3 129.3

LAPLACE VALUES FCR ROI IRR AND MPS
 0.59561 0.546   2.2657


PROJECT NUMBER:20

INPUT VARIABLES:
  TOTAL COST      :1871.7
  TOTAL SAVINGS :52637
  MANPOWER SAVED:0
  CASH FLOWS      :1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9
       1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 18
     79.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9

LAPLACE VALUES FCR ROI IRR AND MPS
 3.1247 0.995  0
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:21

INPUT VARIABLES:
  TOTAL COST     :535.3
  TOTAL SAVINGS  :5863
  MANPOWER SAVED:0
  CASH FLOWS     :586.3 586.3 586.3 586.3 586.3 586.3 586.3 586.3 586.3 586.3

LAPLACE VALUES FCR ROI IRR AND MPS
 1.217 1.084 0


PROJECT NUMBER:22

INPUT VARIABLES:
  TOTAL COST     :476.2
  TOTAL SAVINGS  :5301.1
  MANPOWER SAVED:0
  CASH FLOWS     :764.5 756.1 756.1 756.1 756.1 756.1 756.1

LAPLACE VALUES FCR ROI IRR AND MPS
 1.2369 1.581  0


PROJECT NUMBER:23

INPUT VARIABLES:
  TOTAL COST     :161.6
  TOTAL SAVINGS  :1774.5
  MANPOWER SAVED:12
  CASH FLOWS     :354.9 354.9 354.9 354.9 354.9

LAPLACE VALUES FCR ROI IRR AND MPS
 1.2201 2.168  8.2508
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:24

INPUT VARIABLES:
  TOTAL COST     :135
  TOTAL SAVINGS  :10558
  MANPOWER SAVED:0
  CASH FLOWS     :422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 42
      2.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422
      .3 422.3 422.3

LAPLACE VALUES FOR ROI IRR AND MPS
 8.6893 3.098  0


PROJECT NUMBER:25

INPUT VARIABLES:
  TOTAL COST     :290
  TOTAL SAVINGS  :1421
  MANPOWER SAVED:16
  CASH FLOWS     :209 202 202 202 202 202 202

LAPLACE VALUES FOR ROI IRR AND MPS
 0.54444 0.682   6.1303
```


DPPO Base Case (Con't)

```
PROJECT NUMBER:26

INPUT VARIABLES:
  TOTAL COST     :420
  TOTAL SAVINGS  :8763
  MANPOWER SAVED:0
  CASH FLOWS     :876.3 876.3 876.3 876.3 876.3 876.3 876.3 876.3 876.3 876.3

LAPLACE VALUES FOR ROI IRR AND MPS
 2.3183 2.066  0
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:27

INPUT VARIABLES:
  TOTAL COST     :1351.8
  TOTAL SAVINGS  :14999
  MANPOWER SAVED:72
  CASH FLOWS     :2249.9  2999.8 2999.8 2999.8 3749.8

LAPLACE VALUES FCR ROI IRR AND MPS
 1.2329 1.836  5.918

PROJECT NUMBER:28

INPUT VARIABLES:
  TOTAL COST     :616.9
  TOTAL SAVINGS  :21710
  MANPOWER SAVED:0
  CASH FLOWS     :868.4  868.4  868.4  868.4  868.4  868.4  868.4  868.4  868.4  868.4  86
      8.4 868.4 868.4  868.4  868.4  868.4  868.4  868.4  868.4  868.4  868.4  868.4  868
      .4 868.4 868.4

LAPLACE VALUES FCR ROI IRR AND MPS
 3.9102 1.394  0


PROJECT NUMBER:29

INPUT VARIABLES:
  TOTAL COST     :363.9
  TOTAL SAVINGS  :2647.7
  MANPOWER SAVED:11.4
  CASH FLOWS     :125.9  280.2 280.2  280.2 280.2 280.2 280.2 280.2 280.2 280.2

LAPLACE VALUES FCR ROI IRR AND MPS
 0.80843 0.599   3.4808
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:30

INPUT VARIABLES:
  TOTAL COST     :370
  TOTAL SAVINGS  :3439.7
  MANPOWER SAVED:7.6
  CASH FLOWS     :356.5 367.4 389.3 412.8 437.5 463.7 491.5 521

LAPLACE VALUES FCR ROI IRR AND MPS
 1.0329 0.994  2.2823


PROJECT NUMBER:31

INPUT VARIABLES:
  TOTAL COST     :177
  TOTAL SAVINGS  :1480
  MANPOWER SAVED:3
  CASH FLOWS     :185 185 185 185 185 185 185 185

LAPLACE VALUES FCR ROI IRR AND MPS
 0.92906 1.032   1.8832


PROJECT NUMBER:32

INPUT VARIABLES:
  TOTAL COST     :173.1
  TOTAL SAVINGS  :1897
  MANPOWER SAVED:1.8
  CASH FLOWS     :86.2 86.2 86.2 86.2 86.2 86.2 86.2 0.2 0.2 86.2 0.2 86.2 86.2
      86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2

LAPLACE VALUES FCR ROI IRR AND MPS
 1.2177 0.473  1.1554
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:33

INPUT VARIABLES:
  TOTAL COST     :861.3
  TOTAL SAVINGS  :8366
  MANPOWER SAVED:13.7
  CASH FLOWS     :836.6 836.6 836.6 836.6 836.6 836.6 836.6 836.6 836.6 836.6

LAPLACE VALUES FOR ROI IRR AND MPS
 1.0792 0.961  1.7674


PROJECT NUMBER:34

INPUT VARIABLES:
  TOTAL COST     :520
  TOTAL SAVINGS  :12789
  MANPOWER SAVED:1.5
  CASH FLOWS     :852.6 852.6 852.6 852.6 852.6 852.6 852.6 852.6 852.6 852.6 85
       2.6 852.6 852.6 852.6 852.6

LAPLACE VALUES FOR ROI IRR AND MPS
 2.7327  1.624   0.32051


PROJECT NUMBER:35

INPUT VARIABLES:
  TOTAL COST     :908
  TOTAL SAVINGS  :7200
  MANPOWER SAVED:6
  CASH FLOWS     :900 900 900 900 900 900 900 900

LAPLACE VALUES FOR ROI IRR AND MPS
 0.88106 0.978   0.73421
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:36

INPUT VARIABLES:
  TOTAL COST     :298.7
  TOTAL SAVINGS :2361.6
  MANPOWER SAVED:18
  CASH FLOWS     :295.2 295.2 295.2 295.2 295.2 295.2 295.2 295.2

LAPLACE VALUES FOR ROI IRR AND MPS
 0.87847 0.975   6.6957


PROJECT NUMBER:37

INPUT VARIABLES:
  TOTAL COST     :935
  TOTAL SAVINGS :6700
  MANPOWER SAVED:44.4
  CASH FLOWS     :400 900 900 900 900 900 900 900

LAPLACE VALUES FOR ROI IRR AND MPS
 0.7962 0.72    5.2763


PROJECT NUMBER:38

INPUT VARIABLES:
  TOTAL COST     :199
  TOTAL SAVINGS :2460
  MANPOWER SAVED:2
  CASH FLOWS     :225 235 250 250 250 250 250 250 250 250

LAPLACE VALUES FOR ROI IRR AND MPS
 1.3735 1.158  1.1167
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:39

INPUT VARIABLES:
  TOTAL COST     :635
  TOTAL SAVINGS :4768
  MANPOWER SAVED:15
  CASH FLOWS     :596 596 596 596 596 596 596 596

LAPLACE VALUES FCR ROI IRR AND MPS
 0.8343 0.925  2.6247


PROJECT NUMBER:40

INPUT VARIABLES:
  TOTAL COST     :143.3
  TOTAL SAVINGS :940.8
  MANPOWER SAVED:3.3
  CASH FLOWS     :117.6 117.6 117.6 117.6 117.6 117.6 117.6 117.6

LAPLACE VALUES FCR ROI IRR AND MPS
 0.72947 0.806   2.5587


PROJECT NUMBER:41

INPUT VARIABLES:
  TOTAL COST     :262
  TOTAL SAVINGS :12060
  MANPOWER SAVED:0.3
  CASH FLOWS     :804 804 804 804 804 804 804 804 804 804 804 804 804 804

LAPLACE VALUES FCR ROI IRR AND MPS
 5.1145  3.039   0.12723
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:42

INPUT VARIABLES:
  TOTAL COST     :5931.5
  TOTAL SAVINGS  :23261
  MANPOWER SAVED:651.2
  CASH FLOWS     :4788.5 6226 3987.7 3987.8 1067.7 1067.7 1067.7 1067.7

LAPLACE VALUES FCR ROI IRR AND MPS
  0.43573  0.763   12.199


PROJECT NUMBER:43

INPUT VARIABLES:
  TOTAL COST     :3182
  TOTAL SAVINGS  :45950
  MANPOWER SAVED:4
  CASH FLOWS     :500 1000 2030 6060 6060 6060 6060 6060 6060 6060

LAPLACE VALUES FCR ROI IRR AND MPS
 1.6045  0.641   0.13967


PROJECT NUMBER:44

INPUT VARIABLES:
  TOTAL COST     :870
  TOTAL SAVINGS  :9427.4
  MANPOWER SAVED:13.6
  CASH FLOWS     :541.9 604.5 828.1 828.1 828.1 828.1 828.1 828.1 828.1 828.1 82
      8.1 828.1

LAPLACE VALUES FCR ROI IRR AND MPS
 1.204  0.741  1.7369
```

DPPO Base Case (Con't)

```
PROJECT NUMBER:45

INPUT VARIABLES:
  TOTAL COST     :121
  TOTAL SAVINGS  :672
  MANPOWER SAVED:2
  CASH FLOWS     :84 84 84 84 84 84 84 84

LAPLACE VALUES FOR ROI IRR AND MPS
 0.61708 0.677    1.8365


PROJECT NUMBER:46

INPUT VARIABLES:
  TOTAL COST     :105.8
  TOTAL SAVINGS  :828
  MANPOWER SAVED:2.5
  CASH FLOWS     :41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41
      .4 41.4 41.4 41.4 41.4 41.4 41.4 41.4

LAPLACE VALUES FOR ROI IRR AND MPS
 0.86957 0.387    2.6255


PROJECT NUMBER:47

INPUT VARIABLES:
  TOTAL COST     :294.9
  TOTAL SAVINGS  :4857
  MANPOWER SAVED:2
  CASH FLOWS     :485.7 485.7 485.7 485.7 485.7 485.7 485.7 485.7 485.7 485.7

LAPLACE VALUES FOR ROI IRR AND MPS
 1.83     1.631    0.75355
```

DPPO Base Case (Con't)

NO	ROI	IRR	MPS
1	44.445	6.626	15.721
2	7.309	0.900	22.287
3	23.469	0.587	49.078
4	22.951	3.654	14.925
5	25.806	0.628	0.000
6	4.852	0.676	50.880
7	25.590	1.014	0.000
8	27.565	1.092	0.000
9	16.083	0.737	0.000
10	5.398	1.039	82.978
11	17.663	2.287	39.944
12	19.852	1.966	0.000
13	11.665	0.578	8.877
14	15.950	0.790	12.500
15	32.284	4.567	7.178
16	10.149	1.004	33.852
17	13.508	1.260	0.000
18	13.946	1.138	4.761
19	5.360	0.546	20.392
20	28.123	0.995	0.000
21	10.953	1.084	0.000
22	11.132	1.581	0.000
23	10.981	2.168	74.257
24	78.204	3.098	0.000
25	4.900	0.682	25.172
26	20.864	2.066	0.000
27	11.096	1.836	53.262
28	35.192	1.394	0.000
29	7.275	0.599	31.327
30	9.296	0.994	20.541
31	8.361	1.032	16.949
32	10.959	0.473	10.399
33	9.713	0.961	15.906
34	24.594	1.624	2.884
35	7.929	0.978	6.607
36	7.906	0.975	60.261
37	7.166	0.720	47.487
38	12.362	1.158	10.050
39	7.509	0.925	23.622
40	6.565	0.806	23.029
41	46.031	3.039	1.145
42	3.922	0.763	109.790
43	14.441	0.641	1.257
44	10.836	0.741	15.632
45	5.554	0.677	16.529
46	7.826	0.387	23.629
47	16.470	1.631	6.782

DPPO Base Case (Con't)

THE FINAL RANKING:

NO	RANK
1	1
2	31
3	12
4	5
5	37
6	39
7	22
8	19
9	42
10	16.5
11	2
12	15
13	43
14	25
15	3.5
16	14
17	26
18	20
19	47
20	21
21	36
22	27
23	3.5
24	8
25	34.5
26	13
27	6
28	11
29	40.5
30	24
31	23
32	45
33	28.5
34	9
35	38
36	18
37	32
38	16.5
39	28.5
40	34.5
41	7
42	30
43	40.5
44	33
45	46
46	44
47	10

APPENDIX D

UNCERTAINTY BASE CASE

This appendix contains the results of the initial runs used to determine the impact of uncertainty on DPPO's current procedures.

```
RUN NUMBER: UNCERTAINTY BASE CASE

DEVIATION LEVELS:
  COST      :1.256 1 0.825
  SAVINGS   :1.014 1 0.3316
  MANPOWER  :1.1 1 0.9
  CASHFLOWS:1.014 1 0.3316


PROJECT NUMBER:1

INPUT VARIABLES:
  TOTAL COST      :572.5
  TOTAL SAVINGS :25445
  MANPOWER SAVED:9
  CASH FLOWS      :3585 5465 5465 5465 5465

LAPLACE VALUES FOR ROI IRR AND MPS
 34.847   5.2363 15.764


PROJECT NUMBER:2

INPUT VARIABLES:
  TOTAL COST      :21178
  TOTAL SAVINGS :1.548E5
  MANPOWER SAVED:472
  CASH FLOWS      :19350 19350 19350 19350 19350 19350 19350 19350

LAPLACE VALUES FOR ROI IRR AND MPS
  5.7307   0.68767 22.349
```

```
PROJECT NUMBER:3

INPUT VARIABLES:
  TOTAL COST     :5542.2
  TOTAL SAVINGS  :1.3007E5
  MANPOWER SAVED:272
  CASH FLOWS     :0 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202
      .9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9
      5202.9 5202.9 5202.9 5202.9 5202.9 5202.9 5202.9

LAPLACE VALUES FCR ROI IRR AND MPS
 18.401    0.47567 49.214


PROJECT NUMBER:4

INPUT VARIABLES:
  TOTAL COST     :268
  TOTAL SAVINGS  :6151
  MANPOWER SAVED:4
  CASH FLOWS     :957 1044.5  1322.5  1413.5 1413.5

LAPLACE VALUES FOR ROI IRR AND MPS
 17.995   2.8747 14.967


PROJECT NUMBER:5

INPUT VARIABLES:
  TOTAL COST     :629.9
  TOTAL SAVINGS  :16255
  MANPOWER SAVED:0
  CASH FLOWS     :0 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2
      650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 650.2 6
      50.2 650.2

LAPLACE VALUES FCR ROI IRR AND MPS
 20.232  0.51   0
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:6

INPUT VARIABLES:
  TOTAL COST     :1033.8
  TOTAL SAVINGS  :5016.7
  MANPOWER SAVED:52.6
  CASH FLOWS     :716.7 716.7 716.7 716.7 716.7 716.7 716.7 716.5

LAPLACE VALUES FOR ROI IRR AND MPS
  3.8046    0.50633 51.021


PROJECT NUMBER:7

INPUT VARIABLES:
  TOTAL COST     :784.2
  TOTAL SAVINGS  :20068
  MANPOWER SAVED:0
  CASH FLOWS     :802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 80
      2.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802.7 802
      .7 802.7 802.7

LAPLACE VALUES FCR ROI IRR AND MPS
 20.063     0.79267  0


PROJECT NUMBER:8

INPUT VARIABLES:
  TOTAL COST     :1026.4
  TOTAL SAVINGS  :28293
  MANPOWER SAVED:0
  CASH FLOWS     :1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7
       1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 1131.7 11
      31.7 1131.7 1131.7 1131.7 1131.7 1131.7

LAPLACE VALUES FCR ROI IRR AND MPS
 21.612     0.85367  0
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:9

INPUT VARIABLES:
  TOTAL COST     :1711.7
  TOTAL SAVINGS  :27530
  MANPOWER SAVED:0
  CASH FLOWS     :1115.8 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2
       1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 1390.2 13
     90.2

LAPLACE VALUES FCR ROI IRR AND MPS
 12.61      0.57933  0


PROJECT NUMBER:10

INPUT VARIABLES:
  TOTAL COST     :468.8
  TOTAL SAVINGS  :2531
  MANPOWER SAVED:38.9
  CASH FLOWS     :506.2 506.2 506.2 506.2 506.2

LAPLACE VALUES FCR ROI IRR AND MPS
  4.2329   0.774   83.207


PROJECT NUMBER:11

INPUT VARIABLES:
  TOTAL COST     :14345
  TOTAL SAVINGS  :2.5337E5
  MANPOWER SAVED:573
  CASH FLOWS     :33912 31352 31352 31352 31352 31352 31352 31352

LAPLACE VALUES FCR ROI IRR AND MPS
 13.848    1.7803 40.055
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:12

INPUT VARIABLES:
  TOTAL COST     :1894
  TOTAL SAVINGS  :37600
  MANPOWER SAVED:0
  CASH FLOWS     :3760 3760 3760 3760 3760 3760 3760 3760 3760 3760

LAPLACE VALUES FOR ROI IRR AND MPS
 15.565  1.536  0


PROJECT NUMBER:13

INPUT VARIABLES:
  TOTAL COST     :788.5
  TOTAL SAVINGS  :9198
  MANPOWER SAVED:7
  CASH FLOWS     :459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 45
      9.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9 459.9

LAPLACE VALUES FOR ROI IRR AND MPS
 9.1459 0.45   8.9022


PROJECT NUMBER:14

INPUT VARIABLES:
  TOTAL COST     :240
  TOTAL SAVINGS  :3828
  MANPOWER SAVED:3
  CASH FLOWS     :191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 19
      1.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4 191.4

LAPLACE VALUES FOR ROI IRR AND MPS
 12.505  0.617 12.535
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:15

INPUT VARIABLES:
  TOTAL COST     :2020
  TOTAL SAVINGS  :65214
  MANPOWER SAVED:14.5
  CASH FLOWS     :9316.3 9316.3 9316.3 9316.3 9316.3 9316.3 9316.3

LAPLACE VALUES FCR ROI IRR AND MPS
 25.312   3.57     7.1981


PROJECT NUMBER:16

INPUT VARIABLES:
  TOTAL COST     :147.7
  TOTAL SAVINGS  :1499
  MANPOWER SAVED:5
  CASH FLOWS     :149.9 149.9 149.9 149.9 149.9 149.9 149.9 149.9 149.9 149.9

LAPLACE VALUES FCR ROI IRR AND MPS
  7.9571  0.778  33.946


PROJECT NUMBER:17

INPUT VARIABLES:
  TOTAL COST     :138.7
  TOTAL SAVINGS  :1873.5
  MANPOWER SAVED:0
  CASH FLOWS     :143.5 219.5 217.5 215.5 215.5 215.5 215.5 215.5 215.5

LAPLACE VALUES FCR ROI IRR AND MPS
 10.59     0.99267  0
```

PROJECT NUMBER:18

INPUT VARIABLES:
  TOTAL COST   :126
  TOTAL SAVINGS :1757.2
  MANPOWER SAVED:0.6
  CASH FLOWS   :89.2 208.5 208.5 208.5 208.5 208.5 208.5 208.5 208.5

LAPLACE VALUES FOR ROI IRR AND MPS
 10.934   0.906   4.7751

PROJECT NUMBER:19

INPUT VARIABLES:
  TOTAL COST   :245.2
  TOTAL SAVINGS :1314.4
  MANPOWER SAVED:5
  CASH FLOWS   :150.7 129.3 129.3 129.3 129.3 129.3 129.3 129.3 129.3 129.3

LAPLACE VALUES FOR ROI IRR AND MPS
  4.2028   0.40733 20.448

PROJECT NUMBER:20

INPUT VARIABLES:
  TOTAL COST   :1871.7
  TOTAL SAVINGS :52637
  MANPOWER SAVED:0
  CASH FLOWS   :1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9
       1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 18
     79.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9 1879.9

LAPLACE VALUES FOR ROI IRR AND MPS
 22.049 0.778 0

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:21

INPUT VARIABLES:
  TOTAL COST     :535.3
  TOTAL SAVINGS :5863
  MANPOWER SAVED:0
  CASH FLOWS     :586.3 586.3 586.3 586.3 586.3 586.3 586.3 586.3 586.3 586.3

LAPLACE VALUES FOR ROI IRR AND MPS
 8.5873  0.84133 0


PROJECT NUMBER:22

INPUT VARIABLES:
  TOTAL COST     :476.2
  TOTAL SAVINGS :5301.1
  MANPOWER SAVED:0
  CASH FLOWS     :764.5 756.1 756.1 756.1 756.1 756.1 756.1

LAPLACE VALUES FOR ROI IRR AND MPS
 8.7279 1.2257 0


PROJECT NUMBER:23

INPUT VARIABLES:
  TOTAL COST     :161.6
  TOTAL SAVINGS :1774.5
  MANPOWER SAVED:12
  CASH FLOWS     :354.9 354.9 354.9 354.9 354.9

LAPLACE VALUES FOR ROI IRR AND MPS
  8.6093  1.6773 74.463
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:24

INPUT VARIABLES:
  TOTAL COST      :135
  TOTAL SAVINGS :10558
  MANPOWER SAVED:0
  CASH FLOWS      :422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 42
      2.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422.3 422
      .3 422.3 422.3

LAPLACE VALUES FOR ROI IRR AND MPS
 61.314   2.4223  0


PROJECT NUMBER:25

INPUT VARIABLES:
  TOTAL COST      :290
  TOTAL SAVINGS :1421
  MANPOWER SAVED:16
  CASH FLOWS      :209 202 202 202 202 202 202

LAPLACE VALUES FOR ROI IRR AND MPS
  3.8417   0.50333 55.325


PROJECT NUMBER:26

INPUT VARIABLES:
  TOTAL COST      :420
  TOTAL SAVINGS :8763
  MANPOWER SAVED:0
  CASH FLOWS      :876.3 876.3 876.3 876.3 876.3 876.3 876.3 876.3 876.3 876.3

LAPLACE VALUES FOR ROI IRR AND MPS
 16.358   1.6143  0
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:27

INPUT VARIABLES:
  TOTAL COST     :1351.8
  TOTAL SAVINGS  :14999
  MANPOWER SAVED:72
  CASH FLOWS     :2249.9 2999.8 2999.8 2999.8 3749.8

LAPLACE VALUES FOR ROI IRR AND MPS
  8.6993  1.4327 53.41


PROJECT NUMBER:28

INPUT VARIABLES:
  TOTAL COST     :616.9
  TOTAL SAVINGS  :21710
  MANPOWER SAVED:0
  CASH FLOWS     :868.4 868.4 868.4 868.4 868.4 868.4 868.4 868.4 868.4 868.4 86
      8.4 868.4 868.4 868.4 868.4 868.4 868.4 868.4 868.4 868.4 868.4 868
      .4 868.4 868.4

LAPLACE VALUES FOR ROI IRR AND MPS
 27.592   1.0903  0


PROJECT NUMBER:29

INPUT VARIABLES:
  TOTAL COST     :363.9
  TOTAL SAVINGS  :2647.7
  MANPOWER SAVED:11.4
  CASH FLOWS     :125.9 280.2 280.2 280.2 280.2 280.2 280.2 280.2 280.2 280.2

LAPLACE VALUES FOR ROI IRR AND MPS
  5.7045   0.46333 31.414
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:30

INPUT VARIABLES:
  TOTAL COST     :370
  TOTAL SAVINGS :3439.7
  MANPOWER SAVED:7.6
  CASH FLOWS     :356.5 367.4 389.3 412.8 437.5 463.7 491.5 521

LAPLACE VALUES FOR ROI IRR AND MPS
  7.2887   0.77233 20.597


PROJECT NUMBER:31

INPUT VARIABLES:
  TOTAL COST     :177
  TOTAL SAVINGS :1480
  MANPOWER SAVED:3
  CASH FLOWS     :185 185 185 185 185 185 185 185

LAPLACE VALUES FOR ROI IRR AND MPS
  6.5557   0.79333 16.996


PROJECT NUMBER:32

INPUT VARIABLES:
  TOTAL COST     :173.1
  TOTAL SAVINGS :1897
  MANPOWER SAVED:1.8
  CASH FLOWS     :86.2 86.2 86.2 86.2 86.2 86.2 86.2 0.2 0.2 86.2 0.2 86.2 86.2
      86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2 86.2

LAPLACE VALUES FOR ROI IRR AND MPS
  8.5922   0.36333 10.427
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:33

INPUT VARIABLES:
  TOTAL COST     :861.3
  TOTAL SAVINGS  :8366
  MANPOWER SAVED:13.7
  CASH FLOWS     :836.6 836.6 836.6 836.6 836.6 836.6 836.6 836.6 836.6 836.6

LAPLACE VALUES FCR ROI IRR AND MPS
  7.6155    0.74567 15.95


PROJECT NUMBER:34

INPUT VARIABLES:
  TOTAL COST     :520
  TOTAL SAVINGS  :12789
  MANPOWER SAVED:1.5
  CASH FLOWS     :852.6 852.6 852.6 852.6 852.6 852.6 852.6 852.6 852.6 852.6 85
      2.6 852.6 852.6 852.6 852.6

LAPLACE VALUES FCR ROI IRR AND MPS
 19.283    1.2697  2.8926


PROJECT NUMBER:35

INPUT VARIABLES:
  TOTAL COST     :908
  TOTAL SAVINGS  :7200
  MANPOWER SAVED:6
  CASH FLOWS     :900 900 900 900 900 900 900 900

LAPLACE VALUES FCR ROI IRR AND MPS
 6.217    0.75033 6.6262
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:36

INPUT VARIABLES:
  TOTAL COST     :298.7
  TOTAL SAVINGS :2361.6
  MANPOWER SAVED:18
  CASH FLOWS     :295.2 295.2 295.2 295.2 295.2 295.2 295.2 295.2

LAPLACE VALUES FCR ROI IRR AND MPS
  6.1987  0.748  60.428


PROJECT NUMBER:37

INPUT VARIABLES:
  TOTAL COST     :935
  TOTAL SAVINGS :6700
  MANPOWER SAVED:44.4
  CASH FLOWS     :400 900 900 900 900 900 900 900

LAPLACE VALUES FCR ROI IRR AND MPS
  5.6182   0.55633 47.618


PROJECT NUMBER:38

INPUT VARIABLES:
  TOTAL COST     :199
  TOTAL SAVINGS :2460
  MANPOWER SAVED:2
  CASH FLOWS     :225 235 250 250 250 250 250 250 250 250

LAPLACE VALUES FCR ROI IRR AND MPS
  9.692  0.904 10.078
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:39

INPUT VARIABLES:
  TOTAL COST     :635
  TOTAL SAVINGS  :4768
  MANPOWER SAVED:15
  CASH FLOWS     :596 596 596 596 596 596 596 596

LAPLACE VALUES FOR ROI IRR AND MPS
  5.887     0.70767 23.687


PROJECT NUMBER:40

INPUT VARIABLES:
  TOTAL COST     :143.3
  TOTAL SAVINGS  :940.8
  MANPOWER SAVED:3.3
  CASH FLOWS     :117.6 117.6 117.6 117.6 117.6 117.6 117.6 117.6

LAPLACE VALUES FOR ROI IRR AND MPS
  5.1473    0.61167 23.092


PROJECT NUMBER:41

INPUT VARIABLES:
  TOTAL COST     :262
  TOTAL SAVINGS  :12060
  MANPOWER SAVED:0.3
  CASH FLOWS     :804 804 804 804 804 804 804 804 804 804 804 804 804 804

LAPLACE VALUES FOR ROI IRR AND MPS
 36.089    2.376    1.1482
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:42

INPUT VARIABLES:
  TOTAL COST     :5931.5
  TOTAL SAVINGS  :23261
  MANPOWER SAVED:651.2
  CASH FLOWS     :4788.5 6226 3987.7 3987.8 1067.7 1067.7 1067.7 1067.7

LAPLACE VALUES FOR ROI IRR AND MPS
   3.0746    0.544   110.09


PROJECT NUMBER:43

INPUT VARIABLES:
  TOTAL COST     :3182
  TOTAL SAVINGS  :45950
  MANPOWER SAVED:4
  CASH FLOWS     :500 1000 2030 6060 6060 6060 6060 6060 6060 6060

LAPLACE VALUES FOR ROI IRR AND MPS
 11.322     0.52933   1.2605


PROJECT NUMBER:44

INPUT VARIABLES:
  TOTAL COST     :870
  TOTAL SAVINGS  :9427.4
  MANPOWER SAVED:13.6
  CASH FLOWS     :541.9 604.5 828.1 828.1 828.1 828.1 828.1 828.1 828.1 828.1 82
      8.1 828.1

LAPLACE VALUES FOR ROI IRR AND MPS
  8.4958    0.58267  15.675
```

Uncertainty Base Case (Con't)

```
PROJECT NUMBER:45

INPUT VARIABLES:
  TOTAL COST     :121
  TOTAL SAVINGS :672
  MANPOWER SAVED:2
  CASH FLOWS     :84 84 84 84 84 84 84 84

LAPLACE VALUES FOR ROI IRR AND MPS
  4.3543  0.507  16.575

PROJECT NUMBER:46


INPUT VARIABLES:
  TOTAL COST     :105.8
  TOTAL SAVINGS :828
  MANPOWER SAVED:2.5
  CASH FLOWS     :41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41.4 41
      .4 41.4 41.4 41.4 41.4 41.4 41.4 41.4

LAPLACE VALUES FOR ROI IRR AND MPS
  6.1359  0.298  23.695


PROJECT NUMBER:47

INPUT VARIABLES:
  TOTAL COST     :294.9
  TOTAL SAVINGS :4857
  MANPOWER SAVED:2
  CASH FLOWS     :485.7 485.7 485.7 485.7 485.7 485.7 485.7 485.7 485.7 485.7

LAPLACE VALUES FOR ROI IRR AND MPS
 12.913   1.273   6.8007
```

Uncertainty Base Case (Con't)

NO	MAXRCI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.6270	11.7340	6.714	2.369	20.961	11.265
2	8.9838	1.9298	0.913	0.250	29.716	15.970
3	28.8460	6.1962	0.593	0.247	65.437	35.167
4	28.2090	6.0595	3.703	1.267	19.900	10.695
5	31.7180	6.8130	0.635	0.267	0.000	0.000
6	5.9644	1.2812	0.686	0.157	67.840	36.459
7	31.4520	6.7560	1.028	0.336	0.000	0.000
8	33.8800	7.2775	1.107	0.362	0.000	0.000
9	19.7680	4.2462	0.747	0.254	0.000	0.000
10	6.6357	1.4254	1.055	0.228	110.640	59.459
11	21.7090	4.6632	2.320	0.734	53.259	28.622
12	24.4000	5.2412	1.994	0.648	0.000	0.000
13	14.3380	3.0798	0.586	0.186	11.837	6.361
14	19.6040	4.2110	0.801	0.260	16.667	8.957
15	39.6800	8.5234	4.631	1.512	9.571	5.143
16	12.4740	2.6795	1.019	0.311	45.137	24.257
17	16.6020	3.5662	1.276	0.442	0.000	0.000
18	17.1410	3.6819	1.151	0.429	6.349	3.412
19	6.5886	1.4152	0.555	0.121	27.189	14.612
20	34.5650	7.4247	1.009	0.330	0.000	0.000
21	13.4620	2.8917	1.099	0.341	0.000	0.000
22	13.6820	2.9390	1.604	0.492	0.000	0.000
23	13.4960	2.8991	2.199	0.665	99.010	53.210
24	96.1190	20.6470	3.141	1.028	0.000	0.000
25	6.0225	1.2937	0.692	0.136	73.563	39.534
26	25.6440	5.5084	2.095	0.682	0.000	0.000
27	13.6380	2.9294	1.860	0.602	71.016	38.166
28	43.2540	9.2912	1.414	0.463	0.000	0.000
29	8.9427	1.9209	0.606	0.185	41.770	22.448
30	11.4220	2.4544	1.008	0.315	27.387	14.719
31	10.2770	2.2076	1.046	0.302	22.599	12.145
32	13.4700	2.8933	0.480	0.137	13.865	7.451
33	11.9380	2.5644	0.975	0.301	21.208	11.398
34	30.2290	6.4932	1.647	0.538	3.846	2.067
35	9.7461	2.0935	0.992	0.281	8.810	4.735
36	9.7175	2.0874	0.989	0.280	80.348	43.181
37	8.8074	1.8919	0.729	0.220	63.316	34.027
38	15.1940	3.2637	1.174	0.380	13.400	7.201
39	9.2288	1.9824	0.938	0.260	31.496	16.927
40	8.0693	1.7333	0.817	0.212	30.705	16.501
41	56.5760	12.1530	3.081	1.008	1.526	0.820
42	4.8200	1.0353	0.776	0.093	146.380	78.669
43	17.7490	3.8125	0.646	0.301	1.676	0.901
44	13.3190	2.8609	0.750	0.257	20.843	11.201
45	6.8260	1.4663	0.687	0.157	22.039	11.844
46	9.6190	2.0662	0.393	0.114	31.506	16.932
47	20.2430	4.3483	1.654	0.534	9.042	4.859

Uncertainty Base Case (Con't)

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	34	31	31
3	9.5	12	12
4	5	5	5
5	28	34	37
6	42	41	39
7	21	22	22
8	17	18	19
9	38	40	42
10	30	20	16.5
11	2	2	2
12	15	15	15
13	36	43	43
14	23	24.5	25
15	3	3.5	3.5
16	14	14	14
17	25.5	26	26
18	19	19	20
19	47	47	47
20	20	21	21
21	35	36	36
22	28	27	27
23	4	3.5	3.5
24	8	8	8
25	40.5	38.5	34.5
26	13	13	13
27	6	6	6
28	12	11	11
29	37	42	40.5
30	22	24.5	24
31	24	23	23
32	45	45	45
33	25.5	28.5	28.5
34	9.5	9	9
35	39	38.5	38
36	18	16.5	18
37	33	31	32
38	16	16.5	16.5
39	31	28.5	28.5
40	40.5	35	34.5
41	7	7	7
42	43.5	31	30
43	28	37	40.5
44	32	33	33
45	46	46	46
46	43.5	44	44
47	11	10	10

APPENDIX E

SENSITIVITY ANALYSIS RESULTS

This appendix contains the different computer runs performed during sensitivity analysis. Descriptions of the runs are noted at the top of each output.

RUN NUMBER: COST,MPS LOW - SAVINGS HIGH

DEVIATION LEVELS:

COST	:1.256	1	0.2
SAVINGS	:2.2	1	0.33 16
MANPOWER	:1.1	1	0.1
CASHFLOWS	:2.2	1	0.33 16

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	488.90	11.734	14.114	2.369	86.46	1.2516
2	80.40	1.929	1.990	0.250	122.58	1.7744
3	258.16	6.196	1.015	0.247	269.93	3.9075
4	252.47	6.059	7.888	1.267	82.09	1.1883
5	283.86	6.813	1.081	0.267	0.00	0.0000
6	53.37	1.281	1.510	0.157	279.84	4.0510
7	281.49	6.756	2.230	0.336	0.00	0.0000
8	303.21	7.278	2.402	0.362	0.00	0.0000
9	176.92	4.246	1.557	0.254	0.00	0.0000
10	59.38	1.425	2.347	0.228	456.38	6.6065
11	194.29	4.663	5.086	0.734	219.69	3.1803
12	218.37	5.241	4.325	0.648	0.00	0.0000
13	128.32	3.080	1.271	0.186	48.82	0.7068
14	175.45	4.211	1.738	0.260	68.75	0.9952
15	355.13	8.523	10.047	1.512	39.48	0.5715

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	7	7
4	3.5	3.5	3.5
5	7.5	13	13
6	13	11.5	11.5
7	7.5	8.5	8.5
8	6	5.5	5.5
9	14	14.5	14.5
10	10.5	5.5	5.5
11	3.5	3.5	3.5
12	9	8.5	8.5
13	15	14.5	14.5
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST LOW - MANPOWER HIGH

DEVIATION LEVELS:

COST	:1.256	1	0.2
SAVINGS	:1.014	1	0.3316
MANPOWER	:2.2	1	0.9
CASHFLOWS:	1.014	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	225.34	11.734	6.714	2.369	172.93	11.265
2	37.05	1.929	0.913	0.250	245.16	15.970
3	118.99	6.196	0.593	0.247	539.86	35.167
4	116.36	6.059	3.703	1.267	164.18	10.695
5	130.83	6.813	0.635	0.267	0.00	0.000
6	24.60	1.281	0.686	0.157	559.68	36.459
7	129.74	6.756	1.028	0.336	0.00	0.000
8	139.75	7.277	1.107	0.362	0.00	0.000
9	81.54	4.246	0.747	0.254	0.00	0.000
10	27.37	1.425	1.055	0.228	912.76	59.459
11	89.55	4.663	2.320	0.734	439.39	28.622
12	100.65	5.241	1.994	0.648	0.00	0.000
13	59.14	3.079	0.586	0.184	97.65	6.361
14	80.86	4.211	0.801	0.260	137.50	8.957
15	163.68	8.523	4.631	1.512	78.96	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST LOW - MANPOWER LOW

DEVIATION LEVELS:

COST	:1.256	1	0.2
SAVINGS	:1.014	1	0.3316
MANPOWER	:1.1	1	0.2
CASHFLOWS	:1.014	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	225.34	11.734	6.714	2.369	86.46	2.503
2	37.058	1.929	0.913	0.25	122.58	3.548
3	118.990	6.196	0.593	0.247	269.93	7.815
4	116.360	6.059	3.703	1.267	82.09	2.376
5	130.830	6.813	0.635	0.267	0.00	0.000
6	24.603	1.281	0.686	0.157	279.84	8.102
7	129.740	6.756	1.028	0.336	0.00	0.000
8	139.750	7.277	1.107	0.362	0.00	0.000
9	81.542	4.246	0.747	0.254	0.00	0.000
10	27.372	1.425	1.055	0.228	456.38	13.213
11	89.551	4.663	2.320	0.734	219.69	6.360
12	100.650	5.241	1.994	0.648	0.00	0.000
13	59.142	3.079	0.586	0.186	48.82	1.413
14	80.866	4.211	0.801	0.26	68.75	1.990
15	163.680	8.523	4.631	1.512	39.48	1.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: SAVINGS LOW - MANPOWER HIGH

DEVIATION LEVELS:

COST	: 1.256	1	0.825
SAVINGS	: 1.014	1	0.1
MANPOWER	: 2.2	1	0.9
CASHFLOWS	: 1.014	1	0.1

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	3.538	6.714	0.749	41.92	11.265
2	8.983	0.581	0.913	0.066	59.43	15.970
3	28.846	1.868	0.593	0.073	130.87	35.167
4	28.209	1.827	3.703	0.322	39.80	10.695
5	31.718	2.054	0.635	0.080	0.00	0.000
6	5.964	0.386	0.686	0.115	135.68	36.459
7	31.452	2.037	1.028	0.090	0.00	0.000
8	33.880	2.194	1.107	0.099	0.00	0.000
9	19.768	1.280	0.747	0.049	0.00	0.000
10	6.635	0.429	1.055	0.178	221.27	59.459
11	21.709	1.406	2.320	0.146	106.52	28.622
12	24.400	1.580	1.994	0.147	0.00	0.000
13	14.338	0.928	0.586	0.015	23.67	6.361
14	19.604	1.269	0.801	0.049	33.33	8.957
15	39.680	2.570	4.631	0.417	19.14	5.144

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12.5	10	10
3	4.5	5.5	7
4	3	3.5	3.5
5	8	11.5	13
6	12.5	13	11.5
7	8	8	8.5
8	6	5.5	5.5
9	15	14	14
10	11	7	5.5
11	4.5	3.5	3.5
12	8	9	8.5
13	14	15	15
14	10	11.5	11.5
15	2	2	2

RUN NUMBER: COST LOW - SAVINGS LOW

DEVIATION LEVELS:

COST	:1.256	1	0.2
SAVINGS	:1.014	1	0.1
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.014	1	0.1

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	225.340	3.539	6.714	0.749	86.46	11.265
2	37.058	0.582	0.913	0.066	122.58	15.970
3	118.990	1.869	0.593	0.073	269.93	35.167
4	116.360	1.827	3.703	0.322	82.09	10.695
5	130.830	2.054	0.635	0.080	0.00	0.000
6	24.603	0.386	0.686	0.115	279.84	36.459
7	129.740	2.037	1.028	0.090	0.00	0.000
8	139.750	2.195	1.107	0.099	0.00	0.000
9	81.542	1.281	0.747	0.049	0.00	0.000
10	27.372	0.430	1.055	0.178	456.38	59.459
11	89.551	1.406	2.320	0.146	219.69	28.622
12	100.650	1.581	1.994	0.147	0.00	0.000
13	59.142	0.929	0.586	0.015	48.82	6.361
14	80.866	1.270	0.801	0.049	68.75	8.957
15	163.680	2.570	4.631	0.417	39.48	5.144

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12.5	10	10
3	4.5	5.5	7
4	3	3.5	3.5
5	8	11.5	13
6	12.5	13	11.5
7	8	8	8.5
8	6	5.5	5.5
9	15	14	14
10	11	7	5.5
11	4.5	3.5	3.5
12	8	9	8.5
13	14	15	15
14	10	11.5	11.5
15	2	2	2

RUN NUMBER: COST LOW-SAVINGS HIGH

DEVIATION LEVELS:

COST	:1.256	1	0.2
SAVINGS	:2	1	0.33 16
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.5	1	0.33 16

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	133.340	11.734	9.754	2.369	34.585	11.265
2	21.928	1.929	1.356	0.250	49.031	15.970
3	70.408	6.196	0.783	0.247	107.970	35.167
4	68.854	6.059	5.418	1.267	32.836	10.695
5	77.417	6.813	0.836	0.267	0.000	0.000
6	14.558	1.281	1.026	0.157	111.940	36.459
7	76.769	6.756	1.521	0.336	0.000	0.000
8	82.694	7.277	1.638	0.362	0.000	0.000
9	48.250	4.246	1.083	0.254	0.000	0.000
10	16.197	1.425	1.590	0.228	182.550	59.459
11	52.989	4.663	3.452	0.734	87.877	28.622
12	59.556	5.241	2.949	0.648	0.000	0.000
13	34.996	3.079	0.867	0.186	19.531	6.361
14	47.850	4.211	1.185	0.260	27.500	8.957
15	96.853	8.523	6.850	1.512	15.792	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	7	7
4	3.5	3.5	3.5
5	7.5	13	13
6	13	11.5	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14.5
10	10.5	6	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	14.5
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: SAVINGS LOW - MANPOWER LOW

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:1.014	1	0.1
MANPOWER	:1.1	1	0.2
CASHFLOWS	:1.014	1	0.1

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	31.848	6.714	5.998	20.961	2.503
2	8.983	5.237	0.913	0.807	29.716	3.548
3	28.846	16.817	0.593	0.543	65.437	7.815
4	28.209	16.446	3.703	3.301	19.900	2.376
5	31.718	18.491	0.635	0.582	0.000	0.000
6	5.964	3.477	0.686	0.604	67.840	8.102
7	31.452	18.337	1.028	0.913	0.000	0.000
8	33.880	19.752	1.107	0.983	0.000	0.000
9	19.768	11.525	0.747	0.667	0.000	0.000
10	6.635	3.868	1.055	0.926	110.640	13.213
11	21.709	12.657	2.320	2.055	53.259	6.360
12	24.400	14.225	1.994	1.769	0.000	0.000
13	14.338	8.358	0.586	0.520	11.837	1.413
14	19.604	11.429	0.801	0.711	16.667	1.990
15	39.680	23.134	4.631	4.110	9.571	1.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	10	10	10
3	7	7	7
4	3.5	3.5	3.5
5	13	13	13
6	11.5	11.5	11.5
7	8.5	8.5	8.5
8	5.5	5.5	5.5
9	14	14	14
10	5.5	5.5	5.5
11	3.5	3.5	3.5
12	8.5	8.5	8.5
13	15	15	15
14	11.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST,MANPOWER HIGH - SAVINGS LOW

DEVIATION LEVELS:

COST	:2.512	1	0.825
SAVINGS	:1.014	1	0.1
MANPOWER	:2.2	1	0.9
CASHFLOWS:	1.014	1	0.1

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	1.7693	6.714	0.749	41.921	5.632
2	8.983	0.290	0.913	0.066	59.432	7.984
3	28.846	0.934	0.593	0.073	130.870	17.584
4	28.209	0.913	3.703	0.322	39.801	5.347
5	31.718	1.027	0.635	0.080	0.000	0.000
6	5.964	0.193	0.686	0.115	135.680	18.229
7	31.452	1.018	1.028	0.090	0.000	0.000
8	33.880	1.097	1.107	0.099	0.000	0.000
9	19.768	0.640	0.747	0.049	0.000	0.000
10	6.635	0.214	1.055	0.178	221.270	29.729
11	21.709	0.703	2.320	0.146	106.520	14.311
12	24.400	0.790	1.994	0.147	0.000	0.000
13	14.338	0.464	0.586	0.015	23.674	3.180
14	19.604	0.634	0.801	0.049	33.333	4.479
15	39.680	1.285	4.631	0.417	19.142	2.572

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12.5	10	10
3	4.5	5.5	7
4	3	3.5	3.5
5	8	11.5	13
6	12.5	13	11.5
7	8	8	8.5
8	6	5.5	5.5
9	15	14	14
10	11	7	5.5
11	4.5	3.5	3.5
12	8	9	8.5
13	14	15	15
14	10	11.5	11.5
15	2	2	2

RUN NUMBER: COST HIGH-SAVINGS LOW

DEVIATION LEVELS:

COST	:2.512	1	0.825
SAVINGS	:1.014	1	0.1
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.014	1	0.1

NO	MAXRCI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	2.9630	6.714	0.749	20.961	9.43223
2	8.983	0.4872	0.913	0.066	29.716	13.372
3	28.846	1.5646	0.593	0.073	65.437	29.447
4	28.209	1.5301	3.703	0.322	19.900	8.955
5	31.718	1.7204	0.635	0.08	0.000	0.000
6	5.964	0.3235	0.686	0.115	67.840	30.528
7	31.452	1.7060	1.028	0.09	0.000	0.000
8	33.880	1.8377	1.107	0.099	0.000	0.000
9	19.768	1.0722	0.747	0.049	0.000	0.000
10	6.635	0.3599	1.055	0.178	110.640	49.787
11	21.709	1.1775	2.320	0.146	53.259	23.967
12	24.400	1.3235	1.994	0.147	0.000	0.000
13	14.338	0.7776	0.586	0.015	11.837	5.327
14	19.604	1.0633	0.801	0.049	16.667	7.500
15	39.680	2.1523	4.631	0.417	9.571	4.307

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12.5	10	10
3	4.5	5.5	7
4	3	3.5	3.5
5	8	11.5	13
6	12.5	13	11.5
7	8	8	8.5
8	6	5.5	5.5
9	15	14	14
10	11	7	5.5
11	4.5	3.5	3.5
12	8	9	8.5
13	14	15	15
14	10	11.5	11.5
15	2	2	2

RUN NUMBER: COST HIGH - SAVINGS,MPS LOW

DEVIATION LEVELS:

COST	:2.512	1	0.825
SAVINGS	:1.014	1	0.1
MANPOWER	:1.1	1	0.2
CASHFLOWS	:1.014	1	0.1

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	1.769	6.714	0.749	20.961	1.252
2	8.983	0.290	0.913	0.066	29.716	1.774
3	28.846	0.934	0.593	0.073	65.437	3.908
4	28.209	0.913	3.703	0.322	19.900	1.188
5	31.718	1.027	0.635	0.080	0.000	0.000
6	5.964	0.193	0.686	0.115	67.840	4.051
7	31.452	1.018	1.028	0.090	0.000	0.000
8	33.88	1.097	1.107	0.099	0.000	0.000
9	19.768	0.640	0.747	0.049	0.000	0.000
10	6.635	0.214	1.055	0.178	110.640	6.607
11	21.709	0.703	2.320	0.146	53.259	3.180
12	24.400	0.790	1.994	0.147	0.000	0.000
13	14.338	0.464	0.586	0.015	11.837	0.707
14	19.604	0.634	0.801	0.049	16.667	0.995
15	39.680	1.285	4.631	0.417	9.571	0.572

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12.5	10	10
3	4.5	5.5	7
4	3	3.5	3.5
5	8	11.5	13
6	12.5	13	11.5
7	8	8	8.5
8	6	5.5	5.5
9	15	14	14
10	11	7	5.5
11	4.5	3.5	3.5
12	8	9	8.5
13	14	15	15
14	10	11.5	11.5
15	2	2	2

RUN NUMBER: COST LOW

DEVIATION LEVELS:

COST	:1.256	1	0.2
SAVINGS	:1.014	1	0.3316
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.014	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	225.340	11.7340	6.714	2.369	86.463	11.265
2	37.058	1.9298	0.913	0.250	122.580	15.970
3	118.990	6.1962	0.593	0.247	269.930	35.167
4	116.360	6.0595	3.703	1.267	82.090	10.695
5	130.830	6.8130	0.635	0.267	0.000	0.000
6	24.603	1.2812	0.686	0.157	279.840	36.459
7	129.740	6.7560	1.028	0.336	0.000	0.000
8	139.750	7.2775	1.107	0.362	0.000	0.000
9	81.542	4.2462	0.747	0.254	0.000	0.000
10	27.372	1.4254	1.055	0.228	456.380	59.459
11	89.551	4.6632	2.320	0.734	219.690	28.622
12	100.650	5.2412	1.994	0.648	0.000	0.000
13	59.142	3.0798	0.586	0.186	48.827	6.361
14	80.866	4.2110	0.801	0.260	68.750	8.957
15	163.680	8.5234	4.631	1.512	39.480	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: SAVINGS HIGH (2)

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:1.5	1	0.37392
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.5	1	0.37392

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	65.553	13.232	7.985	2.647	20.961	11.265
2	10.781	2.176	1.098	0.301	29.716	15.970
3	34.615	6.987	0.676	0.273	65.437	35.167
4	33.851	6.832	4.419	1.423	19.900	10.695
5	38.061	7.682	0.723	0.295	0.000	0.000
6	7.157	1.444	0.829	0.197	67.840	36.459
7	37.743	7.618	1.234	0.379	0.000	0.000
8	40.656	8.206	1.329	0.409	0.000	0.000
9	23.721	4.788	0.888	0.286	0.000	0.000
10	7.962	1.607	1.280	0.287	110.640	59.459
11	26.051	5.258	2.792	0.833	53.259	28.622
12	29.280	5.910	2.392	0.732	0.000	0.000
13	17.205	3.472	0.703	0.212	11.837	6.361
14	23.525	4.748	0.961	0.294	16.667	8.957
15	47.616	9.611	5.557	1.706	9.571	5.143

THE FINAL RANKINGS LISTED BY METHOD:

PROJ	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	9.5	10	10
3	5.5	6.5	7
4	3.5	3.5	3.5
5	9.5	13	13
6	13	11.5	11.5
7	7	8	8.5
8	5.5	5	5.5
9	14.5	14	14
10	9.5	6.5	5.5
11	3.5	3.5	3.5
12	9.5	9	8.5
13	14.5	15	15
14	12	11.5	11.5
15	2	2	2

RUN NUMBER: COST HIGH

DEVIATION LEVELS:

COST	:2.512	1	0.99
SAVINGS	:1.014	1	0.3116
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.014	1	0.3116

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	45.523	9.188	6.714	2.237	17.467	9.387
2	7.486	1.511	0.913	0.228	24.763	13.308
3	24.038	4.852	0.593	0.234	54.531	29.306
4	23.508	4.745	3.703	1.193	16.584	8.912
5	26.431	5.335	0.635	0.254	0.000	0.000
6	4.970	1.003	0.686	0.138	56.534	30.382
7	26.210	5.290	1.028	0.316	0.000	0.000
8	28.233	5.698	1.107	0.340	0.000	0.000
9	16.473	3.325	0.747	0.238	0.000	0.000
10	5.529	1.116	1.055	0.199	92.198	49.549
11	18.091	3.651	2.320	0.687	44.382	23.852
12	20.333	4.104	1.994	0.608	0.000	0.000
13	11.948	2.411	0.586	0.173	9.864	5.301
14	16.337	3.297	0.801	0.243	13.889	7.464
15	33.067	6.674	4.631	1.420	7.975	4.286

THE FINAL RANKINGS LISTED BY METHOD:

PROJ	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST HIGH - MANPOWER LOW

DEVIATION LEVELS:

COST	: 2.512	1	0.825
SAVINGS	: 1.014	1	0.3316
MANPOWER	: 1.1	1	0.2
CASHFLOWS	: 1.014	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	9.825	6.714	2.369	20.961	6.288
2	8.983	1.615	0.913	0.250	29.716	8.914
3	28.846	5.188	0.593	0.247	65.437	19.631
4	28.209	5.073	3.703	1.267	19.900	5.970
5	31.718	5.704	0.635	0.267	0.000	0.000
6	5.964	1.072	0.686	0.157	67.840	20.352
7	31.452	5.657	1.028	0.336	0.000	0.000
8	33.880	6.093	1.107	0.362	0.000	0.000
9	19.768	3.555	0.747	0.254	0.000	0.000
10	6.635	1.193	1.055	0.228	110.640	33.191
11	21.709	3.904	2.32	0.734	53.259	15.978
12	24.400	4.388	1.994	0.648	0.000	0.000
13	14.338	2.578	0.586	0.186	11.837	3.551
14	19.604	3.526	0.801	0.260	16.667	5.000
15	39.680	7.137	4.631	1.512	9.571	2.871

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST HIGH - MANPOWER HIGH

DEVIATION LEVELS:

COST	:2.512 1 0.825
SAVINGS	:1.014 1 0.3316
MANPOWER	:2.2 1 0.9
CASHFLOWS	:1.014 1 0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	9.825	6.714	2.369	20.961	9.956
2	8.983	1.615	0.913	0.25	29.716	14.115
3	28.846	5.188	0.593	0.247	65.437	31.083
4	28.209	5.073	3.703	1.267	19.900	9.452
5	31.718	5.704	0.635	0.267	0.000	0.000
6	5.964	0.072	0.686	0.157	67.840	32.224
7	31.452	5.657	1.028	0.336	0.000	0.000
8	33.880	6.093	1.107	0.362	0.000	0.000
9	19.768	3.555	0.747	0.254	0.000	0.000
10	6.635	1.193	1.055	0.228	110.640	52.553
11	21.709	3.904	2.320	0.734	53.259	25.298
12	24.400	4.388	1.994	0.648	0.000	0.000
13	14.338	2.578	0.586	0.186	11.837	5.622
14	19.600	3.526	0.801	0.260	16.667	7.916
15	39.680	7.137	4.631	1.512	9.571	4.546

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: UNCERTAINTY BASE

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:1.014	1	0.3116
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.014	1	0.3116

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	11.026	6.714	2.237	20.961	11.265
2	8.983	1.813	0.913	0.228	29.716	15.970
3	28.846	5.822	0.593	0.234	65.437	35.167
4	28.209	5.694	3.703	1.193	19.900	10.695
5	31.718	6.402	0.635	0.254	0.000	0.000
6	5.964	1.203	0.686	0.138	67.840	36.459
7	31.452	6.348	1.028	0.316	0.000	0.000
8	33.880	6.838	1.107	0.340	0.000	0.000
9	19.768	3.990	0.747	0.238	0.000	0.000
10	6.635	1.339	1.055	0.199	110.640	59.459
11	21.709	4.382	2.320	0.687	53.259	28.622
12	24.400	4.925	1.994	0.608	0.000	0.000
13	14.338	2.894	0.586	0.173	11.837	6.361
14	19.604	3.957	0.801	0.243	16.667	8.957
15	39.680	8.009	4.631	1.420	9.571	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: SAVINGS HIGH

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:2.514	1	0.3316
MANPOWER	:1.1	1	0.9
CASHFLOWS	:2.514	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	135.440	11.734	16.066	2.369	20.961	11.265
2	22.274	1.929	2.275	0.250	29.716	15.970
3	71.518	6.196	1.109	0.247	65.437	35.167
4	69.939	6.059	8.997	1.267	19.900	10.695
5	78.637	6.813	1.180	0.267	0.000	0.000
6	14.787	1.281	1.726	0.157	67.840	36.459
7	77.979	6.756	2.548	0.336	0.000	0.000
8	83.997	7.277	2.745	0.362	0.000	0.000
9	49.010	4.246	1.767	0.254	0.000	0.000
10	16.452	1.425	2.684	0.228	110.640	59.459
11	53.824	4.663	5.820	0.734	53.259	28.622
12	60.495	5.241	4.942	0.648	0.000	0.000
13	35.547	3.079	1.452	0.186	11.837	6.361
14	48.604	4.211	1.986	0.260	16.667	8.957
15	98.379	8.523	11.480	1.512	9.571	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	7	7
4	3.5	3.5	3.5
5	7.5	13	13
6	13	11.5	11.5
7	7.5	8.5	8.5
8	6	5.5	5.5
9	14	14.5	14.5
10	10.5	5.5	5.5
11	3.5	3.5	3.5
12	9	8.5	8.5
13	15	14.5	14.5
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: MANPOWER HIGH

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:1.014	1	0.3316
MANPOWER	:2.2	1	0.9
CASHFLOWS	:1.014	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	11.7340	6.714	2.369	41.921	11.265
2	8.983	1.9298	0.913	0.250	59.432	15.970
3	28.846	6.1962	0.593	0.247	130.870	35.167
4	28.209	6.0595	3.703	1.267	39.801	10.695
5	31.718	6.8130	0.635	0.267	0.000	0.000
6	5.964	1.2812	0.686	0.157	135.680	36.459
7	31.452	6.7560	1.028	0.336	0.000	0.000
8	33.880	7.2775	1.107	0.362	0.000	0.000
9	19.768	4.2462	0.747	0.254	0.000	0.000
10	6.635	1.4254	1.055	0.228	221.270	59.459
11	21.709	4.6632	2.320	0.734	106.520	28.622
12	24.400	5.2412	1.994	0.648	0.000	0.000
13	14.338	3.0798	0.586	0.186	23.674	6.361
14	19.604	4.2110	0.801	0.260	33.333	8.957
15	39.680	8.5234	4.631	1.512	19.142	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: SAVINGS LOW

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:1.014	1	0.2
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.014	1	0.2

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	31.848	6.714	5.998	20.961	11.265
2	8.983	5.237	0.913	0.807	29.716	15.970
3	28.846	16.817	0.593	0.543	65.437	35.167
4	28.209	16.446	3.703	3.301	19.900	10.695
5	31.718	18.491	0.635	0.582	0.000	0.000
6	5.964	3.477	0.686	0.604	67.840	36.459
7	31.452	18.337	1.028	0.913	0.000	0.000
8	33.880	19.752	1.107	0.983	0.000	0.000
9	19.768	11.525	0.747	0.667	0.000	0.000
10	6.635	3.868	1.055	0.926	110.640	59.459
11	21.709	12.657	2.320	2.055	53.259	28.622
12	24.400	14.225	1.994	1.769	0.000	0.000
13	14.338	8.358	0.586	0.520	11.837	6.361
14	19.604	11.429	0.801	0.711	16.667	8.957
15	39.680	23.134	4.631	4.110	9.571	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	10	10	10
3	7	7	7
4	3.5	3.5	3.5
5	13	13	13
6	11.5	11.5	11.5
7	8.5	8.5	8.5
8	5.5	5.5	5.5
9	14	14	14
10	5.5	5.5	5.5
11	3.5	3.5	3.5
12	8.5	8.5	8.5
13	15	15	15
14	11.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST LOW (2)

DEVIATION LEVELS:

COST	:1.0048	1	0.66
SAVINGS	:1.014	1	0.3116
MANPOWER	:1.1	1	0.9
CASHFLOWS	:1.014	1	0.3116

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	68.284	13.783	6.714	2.237	26.201	14.081
2	11.230	2.266	0.913	0.228	37.145	19.962
3	36.058	7.278	0.593	0.234	81.797	43.959
4	35.262	7.117	3.703	1.193	24.876	13.369
5	39.647	8.002	0.635	0.254	0.000	0.000
6	7.455	1.504	0.686	0.138	84.800	45.573
7	39.315	7.935	1.028	0.316	0.000	0.000
8	42.350	8.548	1.107	0.340	0.000	0.000
9	24.710	4.987	0.747	0.238	0.000	0.000
10	8.294	1.674	1.055	0.199	138.300	74.323
11	27.137	5.477	2.320	0.687	66.574	35.778
12	30.500	6.156	1.994	0.608	0.000	0.000
13	17.922	3.617	0.586	0.173	14.796	7.951
14	24.505	4.946	0.801	0.243	20.833	11.196
15	49.600	10.012	4.631	1.420	11.964	6.429

THE FINAL RANKINGS LISTED BY METHOD:

PROJ	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: SAVINGS HIGH - MPS HIGH

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:2	1	0.3316
MANPOWER	:2.2	1	0.9
CASHFLOWS	:2	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	107.750	11.7340	12.869	2.369	38.110	11.265
2	17.720	1.9298	1.809	0.250	54.029	15.970
3	56.896	6.1962	0.953	0.247	118.980	35.167
4	55.640	6.0595	7.182	1.267	36.183	10.695
5	62.559	6.8130	1.015	0.267	0.000	0.000
6	11.764	1.2812	1.372	0.157	123.350	36.459
7	62.036	6.7560	2.027	0.336	0.000	0.000
8	66.824	7.2775	2.184	0.362	0.000	0.000
9	38.990	4.2462	1.422	0.254	0.000	0.000
10	13.088	1.4254	2.132	0.228	201.160	59.459
11	42.819	4.6632	4.619	0.734	96.835	28.622
12	48.126	5.2412	3.932	0.648	0.000	0.000
13	28.279	3.0798	1.155	0.186	21.521	6.361
14	38.667	4.2110	1.580	0.260	30.303	8.957
15	78.265	8.5234	9.133	1.512	17.402	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	7	7
4	3.5	3.5	3.5
5	7.5	13	13
6	13	11.5	11.5
7	7.5	8.5	8.5
8	6	5.5	5.5
9	14	14.5	14.5
10	10.5	5.5	5.5
11	3.5	3.5	3.5
12	9	8.5	8.5
13	15	14.5	14.5
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST HIGH - SAVINGS HIGH

DEVIATION LEVELS:

COST	:2.512	1	0.825
SAVINGS	:2	1	0.3316
MANPOWER	:1.1	1	0.9
CASHFLOWS	:2	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	107.750	5.8671	12.869	2.369	20.961	5.632
2	17.720	0.9648	1.809	0.250	29.716	7.984
3	56.896	3.0981	0.953	0.247	65.437	17.584
4	55.640	3.0297	7.182	1.267	19.900	5.347
5	62.559	3.4065	1.015	0.267	0.000	0.000
6	11.764	0.6405	1.372	0.157	67.840	18.229
7	62.036	3.3780	2.027	0.336	0.000	0.000
8	66.824	3.6387	2.184	0.362	0.000	0.000
9	38.990	2.1231	1.422	0.254	0.000	0.000
10	13.088	0.7126	2.132	0.228	110.640	29.729
11	42.819	2.3316	4.619	0.734	53.259	14.311
12	48.126	2.6206	3.932	0.648	0.000	0.000
13	28.279	1.5399	1.155	0.186	11.837	3.180
14	38.667	2.1055	1.580	0.260	16.667	4.478
15	78.265	4.2617	9.13	1.512	9.571	2.571

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	7	7
4	3.5	3.5	3.5
5	7.5	13	13
6	13	11.5	11.5
7	7.5	8.5	8.5
8	6	5.5	5.5
9	14	14.5	14.5
10	10.5	5.5	5.5
11	3.5	3.5	3.5
12	9	8.5	8.5
13	15	14.5	14.5
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: SAVINGS HIGH - MPS LOW

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:2	1	0.3316
MANPOWER	:1.1	1	0.2
CASHFLOWS	:2	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	107.750	11.7340	12.869	2.369	20.961	2.503
2	17.720	1.9298	1.809	0.250	29.716	3.548
3	56.896	6.1962	0.953	0.247	65.437	7.815
4	55.640	6.0595	7.182	1.267	19.900	2.376
5	62.559	6.8130	1.015	0.267	0.000	0.000
6	11.764	1.2812	1.372	0.157	67.840	8.102
7	62.036	6.7560	2.027	0.336	0.000	0.000
8	66.824	7.2775	2.184	0.362	0.000	0.000
9	38.990	4.2462	1.422	0.254	0.000	0.000
10	13.088	1.4254	2.132	0.228	110.640	13.213
11	42.819	4.6632	4.619	0.734	53.259	6.360
12	48.126	5.2412	3.932	0.648	0.000	0.000
13	28.279	3.0798	1.155	0.186	11.837	1.413
14	38.667	4.2110	1.580	0.260	16.667	1.990
15	78.265	8.5234	9.133	1.512	9.571	1.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	7	7
4	3.5	3.5	3.5
5	7.5	13	13
6	13	11.5	11.5
7	7.5	8.5	8.5
8	6	5.5	5.5
9	14	14.5	14.5
10	10.5	5.5	5.5
11	3.5	3.5	3.5
12	9	8.5	8.5
13	15	14.5	14.5
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: MANPOWER LOW

DEVIATION LEVELS:

COST	:1.256	1	0.825
SAVINGS	:1.014	1	0.3316
MANPOWER	:1.1	1	0.2
CASHFLOWS	:1.014	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	54.627	11.7340	6.714	2.369	20.961	1.2516
2	8.983	1.9298	0.913	0.250	29.716	1.7744
3	28.846	6.1962	0.593	0.247	65.437	3.9075
4	28.209	6.0595	3.703	1.267	19.900	1.1883
5	31.718	6.8130	0.635	0.267	0.000	0.0000
6	5.964	1.2812	0.686	0.157	67.840	4.0510
7	31.452	6.7560	1.028	0.336	0.000	0.0000
8	33.880	7.2775	1.107	0.362	0.000	0.0000
9	19.768	4.2462	0.747	0.254	0.000	0.0000
10	6.635	1.4254	1.055	0.228	110.640	6.6065
11	21.709	4.6632	2.320	0.734	53.259	3.1803
12	24.400	5.2412	1.994	0.648	0.000	0.0000
13	14.338	3.0798	0.586	0.186	11.837	0.7068
14	19.604	4.2110	0.801	0.260	16.667	0.9952
15	39.680	8.5234	4.631	1.512	9.571	0.5715

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	6.5	7
4	3.5	3.5	3.5
5	7.5	11.5	13
6	13	13	11.5
7	7.5	8	8.5
8	6	5	5.5
9	14	14	14
10	10.5	6.5	5.5
11	3.5	3.5	3.5
12	9	9	8.5
13	15	15	15
14	10.5	11.5	11.5
15	2	2	2

RUN NUMBER: COST LOW - SAVINGS,MPS HIGH

DEVIATION LEVELS:

COST	:1.256	1	0.2
SAVINGS	:2	1	0.3316
MANPOWER	:2.2	1	0.9
CASHFLOWS	:2	1	0.3316

NO	MAXROI	MINROI	MAXIRR	MINIRR	MAXMPS	MINMPS
1	444.450	11.7340	12.869	2.369	157.21	11.265
2	73.093	1.9298	1.809	0.250	222.87	15.970
3	234.690	6.1962	0.953	0.247	490.78	35.167
4	229.510	6.0595	7.182	1.267	149.25	10.695
5	258.060	6.8130	1.015	0.267	0.00	0.000
6	48.527	1.2812	1.372	0.157	508.80	36.459
7	255.900	6.7560	2.027	0.336	0.00	0.000
8	275.650	7.2775	2.184	0.362	0.00	0.000
9	160.830	4.2462	1.422	0.254	0.00	0.000
10	53.989	1.4254	2.132	0.228	829.78	59.459
11	176.630	4.6632	4.619	0.734	399.44	28.622
12	198.520	5.2412	3.932	0.648	0.00	0.000
13	116.650	3.0798	1.155	0.186	88.78	6.361
14	159.500	4.2110	1.580	0.260	125.00	8.957
15	322.840	8.5234	9.133	1.512	71.78	5.143

THE FINAL RANKINGS LISTED BY METHOD:

NO	MAXIMIN	LAPLACE	MAXIMAX
1	1	1	1
2	12	10	10
3	5	7	7
4	3.5	3.5	3.5
5	7.5	13	13
6	13	11.5	11.5
7	7.5	8.5	8.5
8	6	5.5	5.5
9	14	14.5	14.5
10	10.5	5.5	5.5
11	3.5	3.5	3.5
12	9	8.5	8.5
13	15	14.5	14.5
14	10.5	11.5	11.5
15	2	2	2

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